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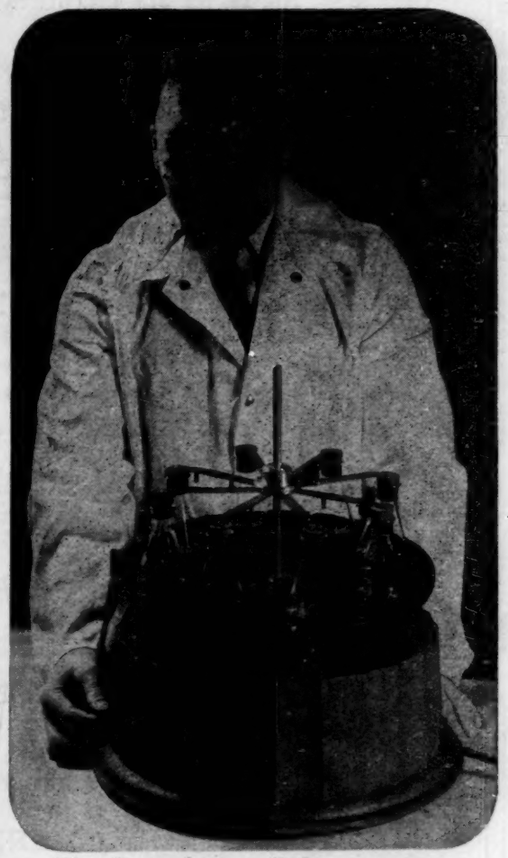

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PHYSIOLOGY AND HIGH ALTITUDE FLYING: WITH PARTICULAR REFERENCE TO AIR EMBOLISM AND THE EFFECTS OF ACCELERATION[1]

By Dr. J. F. FULTON

LABORATORY OF PHYSIOLOGY, YALE UNIVERSITY SCHOOL OF MEDICINE

I. INTRODUCTION

"YE who listen with credulity to the whispers of fancy, and pursue with eagerness the phantoms of hope; who expect that age will perform the promises of youth, and that the deficiencies of the present day will be supplied by the morrow; attend to the history of Rasselas, prince by Abissinia.

"Rasselas was the fourth son of the mighty emperour, in whose dominions the Father of waters begins his course; whose bounty pours down the streams of plenty, and scatters over half the world the harvests of Egypt.

"According to the custom which has descended from age to age among the monarchs of the torrid zone, Rasselas was confined in a private palace, with the other sons and daughters of Abissinian royalty, till the order of succession should call him to the throne."

AND the account goes on to say that the palace of Rasselas was in a spacious Abyssinian valley into which came artists and men of science to advance the

[1] Sigma Xi Lecture delivered before the Yale Chapter in Sage Hall, Yale University, Wednesday, October 15, 1941, and The Duke University Medical Defense Symposium, October 16, 1941.

culture of its happy Utopian population. It so happened one year that a famous artist and engineer came to the valley to settle and the young prince made frequent visits to his house. One day the engineer told Rasselas:

"I have been long of opinion, that, instead of the tardy conveyance of ships and chariots, man might use the swifter migration of wings; that the fields of air are open to knowledge, and that only ignorance and idleness need crawl upon the ground (1, p. 35).... He that can swim needs not despair to fly; to swim is to fly in a grosser fluid, and to fly is to swim in a subtler. We are only to proportion our power of resistance to the different density of the matter through which we are to pass. You will be necessarily up borne by the air, if you can renew any impulse upon it, faster than the air can recede from the pressure (1, p. 36). . . .

"The labour of rising from the ground," said the artist, "will be great, as we see it in the heavier domestick fowls; but, as we mount higher, the earth's attraction, and the body's gravity, will be gradually diminished, till we shall arrive at a region where the man will float in the air without any tendency to fall: no care will then be necessary, but to move forwards, which the gentlest impulse will effect" (1, p. 37–38).

At this juncture Rasselas thought his engineer had gone astray and interjected,

"All this . . . is much to be desired, but I am afraid that no man will be able to breathe in these regions of speculation and tranquility. I have been told, that respiration is difficult upon lofty mountains, yet from these precipices, though so high as to produce great tenuity of the air, it is very easy to fall: therefore I suspect, that from any height, where life can be supported, there may be danger of too quick descent" (1, p. 39).

Rasselas, although unconvinced, was interested and urged the engineer to proceed. This he did under one condition, namely, that Rasselas would divulge to no one the secret of making wings.

"Why," said Rasselas, "should you envy others so great an advantage? All skill ought to be exerted for universal good; every man has owed much to others, and ought to repay the kindness that he has received."

"If men were all virtuous," returned the artist, "I should with great alacrity teach them all to fly. But what would be the security of the good, if the bad could at pleasure invade them from the sky? Against an army sailing through the clouds neither walls, nor mountains, nor seas, could afford any security. A flight of northern savages might hover in the wind, and light at once with irresistible violence upon the capital of a fruitful region that was rolling under them. Even this valley, the retreat of princes, the abode of happiness"—this Abissinia—"might be violated by the sudden descent of some of the naked nations that swarm on the coast of the southern sea" (1, p. 41).

And so Rasselas promised secrecy. The wings were made and the wings were tried, but, like Icarus, the inventor fell into the sea, for he lacked the motive power to flap his wings; and Rasselas rescued his engineer from a watery grave.

Thus, ladies and gentlemen, did Samuel Johnson in 1759 depict the problems of aviation medicine and their relation to warfare. Rasselas was something of a physiologist by temperament, his friend was an inventive engineer, but the engineer was also a realist, for he insisted that certain things can not for the moment be told to the world lest it jeopardize the "security of the good."

If the history of aviation were to be written one would come quickly to appreciate Dr. Johnson's astonishing prescience in characterizing so vividly the developments of modern aeronautics. The modern aeronautical engineer has placed primary emphasis upon design, upon the attainment of speed and quick manoeuverability; in some modern combat planes virtually everything has been sacrificed to gain these two objectives—everything sacrificed including the pilot. It is no secret, for example, that until very recently some of the new bombers designed to fly at 35,000 feet were so cold inside at that altitude as to make it quite impossible for a crew to function effectively for more than a few minutes. I will return to this in a moment.

The second development in modern combat flying has arisen from recognition of the need for protecting the pilot, and at long last aviation engineers are getting together with flight surgeons—and even with physiologists—recognizing that the physical limitations of the pilot are quite as important as the physical characteristics of the machine, and that both must be considered in designing and operating combat aircraft. I propose to deal with three phases of the problem, all essentially physiological, affecting pilot performance at high altitudes, (i) temperature, (ii) aero-embolism and (iii) effects of high acceleration.

II. Temperature

Under standard atmospheric conditions the temperature at 38,000 feet is 55° below zero Fahrenheit; above that stratospheric level the temperature falls but little. The pilot, or the gunner in the open turret, exposed to such a temperature for 8 hours with a wind velocity of 20 m.p.h. is worthless as a gunner; occasionally indeed he has turned out to be a cake of ice.

There have been many studies in war and in peace

time of the influence of cold on human performance. In a word, exposure to intense cold for a sufficient duration to cause perceptible lowering of the rectal temperature makes motor performance slow and inaccurate, and cerebral activity, as indicated by the ability to solve simple problems or to follow simple directions by radio, is gravely impaired. As with nearly all problems involving stress, some individuals are much more affected than others.

The designing engineers have given us planes that will fly to 35,000 and even 40,000 feet, but at first they largely forgot the pilot and the crew, believing that inconveniences from extremes of temperature could be taken care of by clothes from Quartermaster Corps. In single-motored fighter planes, there is little trouble from cold, even in the high altitude ranges, since the pilot sits behind the engine and the cockpit receives direct warmth from it; but in all larger twin-motored or four-motored planes, especially the long-range bombers, the bomb bay is generally open to the outside air and the heating arrangements, especially in the American-made planes, were not only inadequate, but in some of the better known the heating facilities are virtually useless, heaters having been put in the top instead of the bottom of the fusilage. Enormous quantities of heat are available from the exhaust of the long-range bombers, and with little alteration in basic design the exhaust could be made to heat any strategic point in the plane, including the gunner's position. The gunner is more exposed to cold than any other member of the air crew, for in most planes his station in the blister receives the full blast of outside air from the horizontal machine-gun aperture, and in a long mission, the gunner may be at his position for eight hours or more at an altitude of 20,000 feet, at which level the outside temperature would be 25° below zero.

Numerous proposals have been made to combat low temperatures, *e.g.*, electrically heated suits, boots and gloves, and there have been many designs of other types of clothing. Most acute, however, is the need for an oxygen mask and an oxygen line of supply that does not freeze up during prolonged exposure to low temperatures. The Army and Navy have recently released for manufacturers their criteria for oxygen supply systems in which they insist that the oxygen mask and accessory supply valves must not freeze up in one hour with temperature −40° Centigrade in the face of a wind velocity of 10 m.p.h. at an altitude of 37,500 feet. Every mask commercially available at the present time freezes up solid after about 10 minutes of such punishment. Those of you who have recently seen the popular film "Dive Bomber" will have had vividly portrayed the consequences of a frozen system of oxygen supply.

And there are also many vicious circles in connection with cold and high altitude. If very heavy clothing is worn, the crew must do more work in moving about and hence require more oxygen. If the oxygen supply clogs or freezes at 35,000 feet, especially that of a crew member moving heavy bombs, he falls unconscious within 15 seconds or less and the duties of other crew members are generally of such a nature as to prevent their giving prompt assistance. I can not tell you in detail how the problem of cold is being met here or in England, but one can say this, that the flight surgeon is still forced to employ many awkward expedients—all of them I hope temporary—until the heating engineers have solved their phase of the problem, which includes heating, as well as ventilation and also watching for carbon monoxide and other toxic gases.

III. Aero-Embolism

Some of the faster interceptor planes may gain altitude at the surprising rate of a mile a minute; this brings them, if that rate of ascent is maintained, from sea level to 35,000 feet in roughly 7 minutes. Actually, the rate of ascent is inevitably slower in the rarefied air, but it is stated in the newspapers that some of our new fighters have attained altitudes of 36,000 and 37,000 feet within 10 minutes of the time they took off. The pressure of air at 34,000 feet is a quarter of that at sea-level atmosphere—190 mm Hg instead of 760 mm. An aviator arising to 34,000 feet thus subjects himself to the same relative decompression as that experienced by a diver ascending from 100 feet of water—which is equivalent to 4 atmospheres—to the surface level. If a diver ascends too rapidly, nitrogen bubbles tend to form in the tissues and blood stream, and in the same way aviators who subject themselves to rapid decompression are likely to experience the symptoms of bubble formation in their tissues. To divers and to caisson workers, the painful syndrome has long been known as "bends" because the excruciating character of the pains causes those affected to "double up."

The tendency of bubbles to form in the blood under conditions of decompression was first observed by Robert Boyle in the course of those celebrated experiments in which he weighed the air, determined the reciprocal relationship between volume and pressure, and compared combustion with respiration (1662). Boyle observed that when freshly drawn blood was placed in a decompression chamber bubbles were evolved on the surface of the blood as air was being sucked out of the chamber. He asked himself whether these bubbles did not represent the fraction of the air normally taken up when blood passes through the lungs. If this were true, he argued, bubbles should

appear in the blood vessels of animals subjected to rapid decompression. Although Boyle's premise was not wholly correct he was led through this reasoning to make one of the most important observations in the history of our subject. Small bubbles do, in fact, appear in the circulating blood of animals subjected to decompression and this is how Boyle described it in a short note in the *Philosophical Transactions* for September 12, 1670 (2).

> Note, that the two foregoing Experiments were made with an Eye cast upon the inquiry, that I thought might be made; Whether, and how far the destructive operation of our Engin upon the included Animal, might be imputed to this, that upon the withdrawing of the Air, besides the removal of what the Airs presence contributes to life, the little Bubbles generated upon the absence of the Air in th Bloud, juyces, and soft parts of the Body, may by their Vast number, and their conspiring distention, variously streighten in some places, and stretch in others, the Vessels, especially the smaller ones, that convey the Bloud and Nourishment; and so by choaking up some passages, and vitiating the figure of others, disturbe or hinder the due circulation of the Bloud? Not to mention the pains that such distensions may cause in some Nerves, and membranous parts, which by irritating some of them into Convulsions may hasten the death of Animals, and destroy them sooner by occasion of that irritation, than they would be destroyed by the bare absence or loss of what the Air is necessary to supply them with, and to shew how this production of Bubbles reaches even to very minute parts of the Body, I shall add on this occasion (hoping that I have not prevented my self on any other,) what may seem somewhat strange, what I once observed in a *Viper*, furiously tortured in our Exhausted Receiver, namely that it had manifestly a conspicuous Bubble moving to and fro in the waterish humour of one of its Eyes [p. 2044].

Within the past year, our public press has made a great to-do about the dangers of aero-embolism in aviation, and unfortunately the popularity given to the subject has made the average military flier unduly apprehensive about the dangers of "bends." Owing to the developments of the last year, most of which are about to be described in an important paper by Lieutenant Commander A. R. Behnke in the next number of the *Military Surgeon*, "bends" would seem no longer to be a serious problem in military aviation. I would like to state this categorically, and if the press is disposed to cite anything from this paper I hope it will stress this point. The new developments may be briefly outlined as follows:

1. Denitrogenation (a) with oxygen. It has long been suspected that "bends" arise primarily from nitrogen bubbles rather than from oxygen, carbon dioxide or the rarer gases, since nitrogen comprises 80 per cent. of normal air and is rather slow to pass through cell membranes. Once a nitrogen bubble appears, therefore, it is not rapidly absorbed. By breathing pure oxygen for a prolonged period, all the nitrogen of the body, or virtually all of it, can be disposed of. Dr. Behnke (3) has found that when the body is completely denitrogenated, previously susceptible subjects fail, after exposure of several hours to altitudes of 40,000 feet, to develop "bends." Unfortunately the curve of nitrogen elimination shown in Fig. 1 indicates that pure oxygen must be breathed

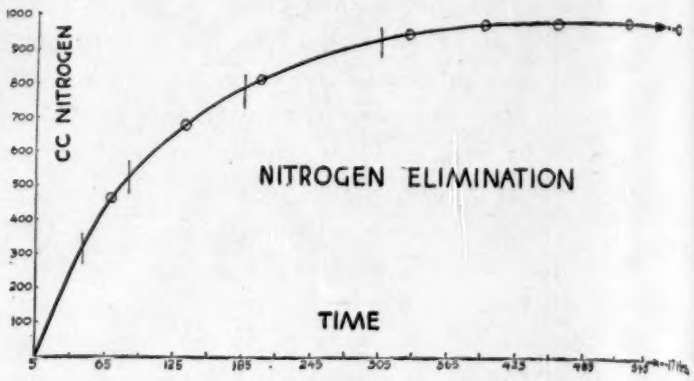

FIG. 1

for at least five hours before 95 per cent. of the body's nitrogen is eliminated. Obviously, therefore, preoxygenation is not a feasible way of preventing "bends," especially for fighter pilots who could not be expected to stay in an atmosphere of pure oxygen for five hours prior to each ascent. The same is true of bomber crews. However, an hour of breathing pure oxygen, as, for example, if the pilot puts on his oxygen mask immediately he enters his plane, will diminish "bends" susceptibility, but will not prevent its ultimate appearance if the exposure to high altitude continues for a long period. In a susceptible subject studied by Commander Behnke severe "bends" developed between 25,000 and 28,000 feet without preoxygenation. With 45 minutes preoxygenation "bends" did not develop until 30,000 feet; with 90 minutes preoxygenation the ceiling was raised to 34,000 feet; with 3 hours to 37,000 feet and after 5 hours preoxygenation the "bends"-susceptible subject withstood 40,000 feet for 2 full hours without experiencing symptoms.

(b) Helium. Oxygen for prolonged administration is hazardous because of its toxicity. Nitrogen can be removed as effectively from the body of a helium-oxygen mixture as with pure oxygen. Since helium is only one third as soluble in fat as is nitrogen, the quantity of gas available for bubble formation, especially in the bone marrow, which comprises as much as 90 per cent. fat, is greatly reduced. If a human being were saturated with helium, instead of nitrogen, it would require only 90 minutes of oxygen inhalation to eliminate dissolved helium in contrast to the 5-hour period for nitrogen elimination. Commander Behnke believes it would be practicable to have bomber pilots in a ready room filled with an atmosphere of oxygen

and helium prior to flight. So far, however, this proposal has not had service trial.

Preselection for high altitude service. The susceptibility to "bends" varies enormously in different individuals, and little is known as yet of the basis for the differing susceptibilities. The younger age groups are less susceptible than the older, and any one having an injury to a joint is prone to develop "bends" at the site of injury. Pilots in the age group of 18 to 24 can often withstand prolonged exposures to altitudes as high as 40,000 feet without developing the symptoms. Behnke and others have recently stressed this point, and it has now become possible on the basis of decompression chamber tests to single out for the high altitude squadrons those pilots who can stand, say, 35,000 feet for 4 hours without developing untoward symptoms. At least 50 per cent. of the young adult population fall into this category, and it is probable that with training the percentage will be even larger. Hence, if pilots are selected through preliminary decompression chamber tests as fit for high altitude operations, "bends" ceases to be a serious military problem.

All the preventive measures elucidated by Commander Behnke and others, even for those who appear to be unsusceptible to "bends," such as taking oxygen from the ground up, ascending slowly and indulging in the limited amount of exercise possible in the cockpit of a plane, are also recommended for observance.

It is possible that certain drugs may diminish "bends"-susceptibility, but as yet there is no panacea for protecting a susceptible subject except for a full 5 hours of preoxygenation.

IV. Effects of Acceleration

An aircraft flying along the curve of any circle, whether in pulling out of a dive, a tight turn or a diving spiral will have acting upon it from the center of the circle a centrifugal acceleration which varies directly as the square of the linear velocity and inversely as the radius of the circle. The actual weight attained by a body during acceleration is the product of the mass and the acceleration expressed in terms of the normal attraction of gravity, *i.e.*, 1 *g*. At a centrifugal acceleration of 7 times the force of gravity (7 *g*), a pilot weighing 180 pounds normally would have a weight, so long as the 7 *g* is sustained, of 1,260 pounds. Every tissue in the body takes part in this increase in weight and as the current RAF *Manual* puts it "at 6.9 *g* the blood becomes as heavy as molten iron." During such acceleration the weight of the hydrostatic column of blood is too great for the heart to cope with on the arterial side and venous blood fails to be returned to the heart from regions of the body below the cardiac level. Hence there tends to be a pooling of blood in the abdomen and lower extremities and failure of the cerebral circulation. The effect of diminished circulation to the retina of the eye manifests itself in graying, and, finally, in ultimate failure of vision—giving the phenomenon of "blackout." When vision goes, consciousness is likely to fail shortly thereafter.

There is a time factor in acceleration as important physiologically as the absolute magnitude of the centrifugal force itself. The average young adult can withstand sitting in the upright position 5 *g* for 4.5 seconds. He might also stand 7 *g* for 2 seconds, but no normal adult can withstand 7 *g* for 7 seconds without complete loss of consciousness. This means that neurons of the brain are so intimately dependent upon their supply of oxygen that when this is withdrawn by centrifugalizing the blood away from the head consciousness lapses, usually within 5 seconds.

The capacity to withstand acceleration varies in different individuals, and in the same individual at different times. Test pilots have found that an alcoholic spree of an evening considerably diminishes their tolerance for positive acceleration the next day. Relative anoxia, such as may occur in high altitudes when the oxygen supply is inadequate, likewise diminishes resistance to acceleration, and it is likely that the level of the blood sugar is similarly important. In recent German literature various expedients have been recommended to assist the pilot to withstand positive acceleration. These may be enumerated briefly.

1. Full stomach. In the recently published diary, "I was a Nazi Flier," there is a diverting chapter on aviation medical research in Germany in which it is stated that all resistance on the part of pilots to being experimented upon was overcome when it became known that the "doctors" had recommended that the pilots of Stuka dive bombers should have a large beefsteak before going off on a mission! From other sources (*e.g.*, Ruff and Strughold, 1939, 4) it is clear that the German flight surgeons insist that an empty stomach diminishes tolerance to high acceleration. When the stomach is full the visceral blood vessels are also distended so that more blood can not readily enter them—so runs the German explanation. Blood chemistry, no doubt, also plays a part in determining resistance to *g*.

2. Carbon dioxide. Use of 5 or 6 per cent. carbon dioxide, which through increasing the cerebral circulation is said by the Germans to increase resistance to acceleration by 1 to 2 *g*. (Ruff and Strughold). This is doubted by other authorities.

3. Vasoconstrictor drugs. Any pharmaceutical agent which increases the "tone" of the capillary wall improves one's *g* ceiling. Pituitrin, adrenalin and adrenal cortical hormones have all been mentioned in

this connection, but precise data concerning these are not available.

4. Pneumatic belts. Mechanical constriction of the abdomen as well as of the lower extremities has also been proposed in both the German and English literature to minimize the rush of blood from the head to the visceral bed and the lower extremities. Of these mechanical devices, pneumatic belts and pneumatic trousers have been most under discussion. The Germans state that a pneumatic belt may increase *g* tolerance by 1 to 1.5, but no one of the present belligerent countries has permitted publication of detailed reports concerning the actual effectiveness of this equipment.

5. Water suits. The Germans have also reported on a "water suit" designed for the prevention of blacking out, and while they claim it notably improves resistance to positive acceleration they state that it is unsatisfactory for other reasons. To quote Grow and Armstrong (1941, pp. 276–277):

> The water suit is a closely fitted water-proof garment which is worn next to the skin. What little space is left in the suit after it is put on is filled with water or other suitable fluid. This causes the flier to "float" in the suit, and during accelerations the water presses on the body equally in all directions. As a consequence the normal effects of acceleration are replaced by a uniform compression of the body which, it is estimated, could be tolerated without difficulty up to 15 gs or more.

6. Posture. In a recent paper by Ruff (1940) in *Medizinische Klinik* the problem of posture in relation to acceleration was discussed. The Germans, it appears, favor a crouching posture with flexion of the legs against the abdomen as one particularly suited for protection of the pilot against acceleration. This would bring the hydrostatic column of blood in the leg veins nearer to the heart level. If the pilot lies supine or prone at the end of a dive-bombing manoeuvre, he is also less subject to negative accelerations, but in these postures he is unable to see out or to manoeuvre his plane without special redesigning of the cockpit and the cockpit controls.

It should be noted that all factors tending to improve the body's resistance to positive acceleration are those which tend to keep blood in the head. From this it may be concluded that the phenomenon of blacking-out and loss of consciousness which may occur within 5 seconds of the beginning of the acceleration is probably due solely to acute anoxia, and can not be attributed to any direct effect of acceleration *per se* upon the cortical neurons.

V. Conclusion

Many other phases of aviation medicine might be discussed, but since there are certain topics that can not be gone into fully at the present time—having in mind Rasselas's "Security of the good"—I have omitted mention of night vision, instrument lighting, the oxygen mask, the adrenals and Drs. Nims and Clarke's studies of pH in anoxia, until some later time when restrictions are less imperative than at present. I hope, however, that I have been able to indicate some of the more important developments as well as the intensely fascinating character of the problems encountered.

I believe that the successful solution of several problems in aviation medicine will determine in large measure the outcome of the present war.

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THE PROBLEM OF THE EXPANDING UNIVERSE[1]

By Dr. EDWIN HUBBLE

MOUNT WILSON OBSERVATORY

Mathematics deals with possible worlds, with the infinite number of logically consistent systems. Observers explore the one particular world we inhabit. Between stands the theorist. He studies possible worlds but only those which are consistent with the information furnished by the observer. In other words, theory attempts to segregate the minimum number of possible worlds which must contain the world we inhabit. Then the observer, with new factual information, reduces the list still further. And so it goes, observation and theory advancing together toward the common goal of science, the structure and behavior of the physical universe in which we live.

The relation is evident in the history of cosmology. The study at first was pure speculation. But slowly, as the exploration of space moved outward, a body of

[1] Abstract of annual Sigma Xi address before the American Association for the Advancement of Science, Dallas, Texas, December 30, 1941.

positive knowledge was assembled which regimented the speculation. The explorations were once confined to the system of the planets. Then, about a century ago, they reached a few of the nearest stars, and, thereafter, ranged through the stellar system. Finally, in our own times, the explorations pushed beyond the stars and swept through the realm of the nebulae, out to the extreme limits of the telescopes. To-day we study a volume of space so vast and so homogeneous that it may represent a fair sample of the universe.

The observable region is a sphere about 1,000 million light years in diameter, throughout which are scattered 100 million nebulae, each a stellar system, comparable with our own system of the Milky Way. These nebulae average about 100 million times brighter than the sun, and several thousand million times more massive. The nebulae are scattered singly, in groups and in clusters but, when large volumes of space are compared, these minor irregularities are not important. On the grand scale, our sample of the universe is approximately homogeneous—very much the same everywhere and in all directions. The smoothed-out average distance between neighboring nebulae is about two million light years, and the intervening space is sensibly transparent.

Another general characteristic of the sample is the law of red shifts. Lines in the spectra of distant nebulae are always found to the red of their normal positions, and these red shifts are directly proportional to the distances of the nebulae—the more distant the nebula, the larger the red shift. The red shifts are frequently explained as velocity shifts (Doppler shifts), indicating actual recession of the nebulae at the rate of about 100 miles per second for each million light years of distance. The phenomenon has been observed out to about 240 million light years where the apparent velocities are nearly 25,000 miles per second. It may be stated with confidence that red shifts either are velocity shifts or they must be referred to some hitherto unrecognized principle in nature.

With this preliminary sketch in mind, let us now turn to the theoretical approach to the problem. Modern cosmological theory attempts to segregate the possible worlds which are consistent with two fundamental principles, general relativity and the cosmological principle. General relativity asserts that the geometry of space is determined by the contents of space. Space is "curved" in the vicinity of matter, and the amount of curvature depends upon the quantity of matter. If the large-scale distribution of matter in the universe is approximately uniform, we may assume a constant curvature or, as it were, "spherical" space. Local irregularities may be disregarded just as mountains and ocean basins are disregarded when we speak of the spherical surface of the earth. The cosmological principle is the simple assumption that there is no favored position in the universe, no center, no boundary. The large-scale aspects of the universe will appear much the same from whatever point they are inspected. This principle implies homogeneity and isotropy.

Possible universes, consistent with the two principles, are found to be unstable. They might be in momentary equilibrium but the balance could not persist. In general, these universes would be either contracting or expanding. At this point, the theorist turns to observations, and accepts the red shifts as visible evidence that our universe is expanding at a rapid rate. Thus arose the concept of homogeneous expanding universes of general relativity.

The problem now passes to the observer. He attempts first to test the assumptions on which the theory is founded and, second, to assemble new information which will identify, among the limited number of possible types, the universe we actually inhabit.

Investigations of this nature have been made during the last five or six years. On the one hand, the assumption of large-scale homogeneity has been reexamined by precisely controlled counts of nebulae to successive limits of apparent faintness. On the other hand, attempts have been made to determine empirically whether or not red shifts do represent actual recession.

The assumption of homogeneity appears to be fairly well established both by deep sampling surveys made at the Mount Wilson and the Lick Observatories, and by those portions of the later counts made at Harvard which are adequately calibrated. If the observable region were divided into a thousand equal parts, their contents would probably be sensibly the same.

The question of red shifts may be examined by means of the dimming effects of recession. A rapidly receding nebula will appear fainter than a similar but stationary nebula at the same momentary distance. The stream of light quanta from the receding nebula is thinned out, and fewer quanta reach the observer each second. Since the rate of impact of the quanta measures the apparent brightness, the receding nebula appears fainter than it would if it were stationary. The dimming factor—the factor by which the normal stationary luminosity is reduced—is merely the velocity of the nebula divided by the velocity of light or, in other words, the red shift expressed as a fraction of the normal wave-length of the light observed. Thus the dimming factor is negligible for the nearer nebulae but reaches about 13 per cent. at the greatest distance reached by the spectrograph, and, presumably, more than 25 per cent. at the limits of direct photography with the 100-inch reflector.

Since we know the intrinsic luminosity (or candle power) of nebulae, the dimming effect could be readily

detected if we knew the precise distances of very remote nebulae. At present, however, such distances are estimated from the apparent faintness itself, which we wish to use for the test. Therefore the direct search for dimming factors ends in a vicious circle.

An indirect approach to the problem is still possible. Apparent faintness of nebulae furnish reliable, statistical distances on two different scales, depending upon whether the dimming factors are included or omitted. Thus we analyze our observational data, determine the precise form of the law of red shifts and the large-scale distribution of nebulae, using first one scale of distance, and then the other scale. The correct scale should lead to a consistent picture of the observable region, while the wrong scale may lead to contradictions or at least to serious difficulties. The procedure has been carried out, and one scale does seem to lead to difficulties. That scale is the one which includes the dimming factors.

If the dimming factors are omitted, the law of red shifts is sensibly linear. In other words, each unit of the light path contributes the same amount of red shift. Furthermore, the large-scale distribution of nebulae is approximately homogeneous. Thus the assumption that red shifts are not velocity shifts but represent some hitherto unknown principle operating in space between the nebulae leads to a very simple, consistent picture of a universe so vast that the observable region must be regarded as an insignificant sample.

On the other hand, when the dimming factors are applied, the scale of distance is necessarily altered. The law of red shifts is no longer linear and the large-scale distribution is no longer homogeneous. These new features specify a particular type of expanding universe but one so small and so young that we hesitate to accept it as the universe we actually inhabit.

The law of red shift is altered in the sense that velocities of recession increase more and more rapidly with distance. Since light we observe to-day left the very remote nebulae far back in past ages, hundreds of millions of years ago, we must conclude that the rate of expansion of the universe has been slowing down. This result is disconcerting.

The present distribution of red shifts could be adequately described on the assumption that all the nebulae were once jammed together in a small volume of space. Then, at a certain instant, about 1,800 million years ago, an explosion occurred, the nebulae rushing outward in all directions and with all velocities. To-day, of course, we find the nebulae distributed according to their initial velocities, those moving most rapidly have reached the greatest distances, while the laggards are still in our vicinity.

Although this picture is over-simplified, it suggests the importance attached to the so-called "age of the universe"—1,800 million years. If the rate of expansion has been diminishing, if the initial velocities have been slowing down, the "age of the universe" must be still further shortened, probably to less than 1,000 million years. Such an interval is a brief moment on the cosmic time scale; it is but a fraction of the age of the earth and is even less than the history of life on the earth. Thus the universe, if it is expanding, is very young indeed—improbably young.

Equally disconcerting results are derived from the studies of nebular distribution. If dimming factors are included, the new scale of distance eliminates the apparent homogeneity. The density, that is the number of nebulae per unit volume of space, increases systematically with distance, in all directions. Such a distribution is not only improbable but it violates the cosmological principle—it suggests that the earth is in a favored position. Therefore, we must assume that the departure from homogeneity is not real but only apparent, and then find a satisfactory explanation.

The only available explanation is a positive spatial curvature which, by a sort of optical foreshortening, would introduce an apparent crowding together of nebulae in a really homogeneous universe. Thus, if the universe is expanding, it is presumably a closed universe of finite volume. Furthermore, the amount of curvature necessary to restore homogeneity is quite large; it leads to a universe so small that we already observe a sensible fraction, perhaps one fourth, of the total volume. Finally, the curvature implies a density of matter in space much greater than can be reasonably accounted for by the observed nebulae alone.

Thus the empirical studies of the law of red shifts and the large-scale distribution of nebulae lead to a dilemma. Red shifts are due either to recession of the nebulae or to some hitherto unrecognized principle operating in internebular space. The latter interpretation leads to the simple conception of a sensibly infinite homogeneous universe of which the observable region is an insignificant fraction.

The alternative interpretation of red shifts as velocity shifts leads to a particular type of an expanding universe which is disconcertingly young, small and dense. Moreover, the strange features of this universe are merely the dimming effects of recession expressed in other terms. Under these circumstances, the inclusion of the dimming factors seems to be a questionable procedure. In other words, the empirical evidence now available does not favor the interpretation of red shifts as velocity shifts.

Two further points may be mentioned. In the first place, the conclusion has no vital effect upon the theory of expanding universes; it merely removes the theory from contact with observations. If red shifts do not

represent actual motion, we may still assume that our universe is either contracting or expanding at a rate that can not now be measured by the observer.

In the second place, the conclusion assumes that the measures on which they are based are reliable. They are all the measures we have which bear on the critical questions and, by the usual criteria of probable errors, they seem to be sufficiently consistent. Nevertheless, the operations are delicate, and the most significant data are found near the extreme limits of the greatest telescopes. Under such conditions, it is always possible that the results may be affected by hidden systematic errors, the nightmare of all observers. This possibility will persist until the critical investigations can be repeated with improved techniques and more powerful telescopes. Ultimately, the matter should be settled beyond question by the 200-inch reflector destined for Mount Palomar.

Meanwhile, on the basis of the evidence now available, a choice seems to be presented, as once before in the days of Copernicus, between a small, finite universe, and a sensibly infinite universe plus a new principle of nature. And, as before, the choice may be determined by the attribute of simplicity.

OBITUARY

SOMA WEISS

DR. SOMA WEISS, of Cambridge, Massachusetts, died suddenly on January 31, 1942, after a brief illness, just having passed his forty-third birthday. At the time of his death he occupied two nationally important medical posts: he was the eighth physician to be Hersey professor of the theory and practice of physic in Harvard University, and the second to be physician-in-chief of the Peter Bent Brigham Hospital in Boston.

He was born in Bestercze, Hungary, but came to the United States as a young man. He graduated from Columbia University in 1921 with the degree of bachelor of arts, and received his medical diploma from Cornell University in 1923. But before this, already he had displayed ability as a teacher and student at the Royal Hungarian University at Budapest, where he served as demonstrator and research fellow in physiology and biochemistry. From the very outset of his career, therefore, he displayed an interest in these two fundamental sciences, and this persisted. He seemed to ask himself continually how things pertaining to medicine happened and how they might be influenced by physiologic and chemical approaches.

In 1925, the Harvard Medical School was able to attract him to Boston by appointing him research fellow in medicine. The opportunities for the investigation and study of disease afforded by the Thorndike Memorial Laboratory of the Boston City Hospital were bound to appeal to a man of his ideals, and here he worked until 1939. His career there served well to illustrate the qualities of imagination and industry which were so prominent in his make-up.

In the Boston City Hospital, he rose from research fellow to assistant director of the Thorndike Memorial Laboratory and physician-in-chief of the Fourth Medical Service—no mean achievement in the course of eleven years for a stranger to Boston. As he grew accustomed to Boston and its medical ways, and as he grew older, besides becoming a master clinician and investigator, he developed also remarkable skill in inspiring men younger or older than himself to learn more: medical students, interns or colleagues. These abilities were so impressive that he ascended the academic ladder of Harvard with equal promptness. He started as an assistant in the department of medicine and became associate professor seven years later.

During the years at the Boston City Hospital, his industry bore fruit in many ways: The patients liked him, for his conscience never allowed him to forget that the patient in the hospital was a human being who might be, like any one else, homesick or lonely, ill in mind as well as body; his colleagues on the staff of the hospital admired and respected him, for he was easy to deal with, unselfish and always honest and straightforward; his students adored him. Whenever he made ward rounds, there would be an enthusiastic following; and one of the important teaching exercises which he conducted with painstaking regularity was that of meeting the house officers of the entire hospital one evening each week, when he would visit other wards than his own and discuss medical problems with others than his own group.

His pen was busy constantly; well over a hundred papers were written during his Boston City Hospital years; and they cover a wide range of subject-matter. They were written only as a man with scientific conscience allows himself to write—always with a careful analysis of what other workers had done previously on the problem under discussion, an account of what his own observations entailed and what he believed they added. To work and teach as he did required not only remarkable industry but also omnivorous reading. On top of all this, he found time to take a sincere interest in various scientific medical societies—the American Association for the Advancement of Science, the American College of Physicians, the American Heart Association, the Association of American Physicians, the Association of Research in Nervous and Mental Diseases, and many others.

In 1938, when the Peter Bent Brigham Hospital needed to appoint a new physician-in-chief, and when

Harvard University needed a new Hersey professor of the theory and practice of physic to succeed Dr. Henry A. Christian, Dr. Weiss seemed an obviously satisfactory choice. So it came about that Dr. Weiss moved from the Thorndike Memorial Laboratory and the Boston City Hospital to the Peter Bent Brigham Hospital and was promoted to one of the most venerable medical professorships in the country.

Two and a half academic years in the life of a university or hospital are not long. Yet, Dr. Weiss will be remembered by Harvard University as having carried forward honorably the fine tradition upheld by his predecessors in the Hersey professorship of the theory and practice of physic; and at the Brigham Hospital, he will be regarded as are Francis Peabody, Harvey Cushing and Henry Christian. For, like them, he did his share to make of this hospital an institution such as the donor wished—a sanctuary where life would be more hopeful and care more possible for sick persons in indigent circumstances residing in the County of Suffolk and for sick persons the world over.

REGINALD FITZ

DEATHS AND MEMORIALS

DR. GLOVER MORRILL ALLEN, associate professor of zoology at Harvard University and curator of mammals at the Agassiz Museum, died on February 14, at the age of sixty-three years.

PROFESSOR FRED W. UPSON, dean emeritus of the Graduate College of the University of Nebraska and a former chairman of the department of chemistry and chemical engineering, died on February 10.

ACCORDING to *Chemical and Engineering News*, as a memorial to E. P. Kohler, professor of chemistry at Bryn Mawr College until 1912 and at the time of his death in May, 1938, Sheldon Emery professor of organic chemistry at Harvard University, a fellowship for graduate study in chemistry has been endowed through contributions from his students. Recipients of the fellowship will be chosen in such a way as to provide for an exchange of outstanding students between the institutions where Kohler taught and those in which the Kohler tradition is particularly cherished.

SCIENTIFIC EVENTS

EXPEDITIONS OF FIELD MUSEUM OF NATURAL HISTORY

FOUR of the five expeditions which Field Museum of Natural History has in Latin-American countries have recently sent to the museum reports on the progress of their work.

Paul O. McGrew, assistant curator of paleontology, who is leader of an expedition in Honduras, reports that he has excavated a specimen of a large and rare dog which lived some 7,000,000 years ago and is similar to a rare type of about the same period that inhabited the North American plains. He has found also a dwarfed type of Pliocene horse which resembles prehistoric North American horses in all characters except size. Its stunted growth may have been due to the unfavorable habitat afforded by the tropics. He writes that the dog is a species almost "certainly new to science, and of great importance." He also writes: "I am amazed and pleased at the high opinion in this country of anything pertaining to 'Los Estados Unidos.'"

Colin Campbell Sanborn, curator of mammals, who is conducting a zoological expedition in Peru, reports that he has collected a large number of animals for the museum. He is engaged in visiting localities of special zoological interest, especially in the valleys of some of the more remote tributaries of the Amazon.

From Cuenca, Ecuador, Donald Collier, ethnologist, sends a preliminary report on explorations on mule-back in little-known regions, and archeological excavations on sites once the seats of prehistoric Indian communities. The museum shares in this expedition with the Institute of Andean Research, New York.

Dr. Julian A. Steyermark, who is conducting a botanical expedition in Guatemala, is working in difficult mountain regions and living largely with native Indians.

The museum's fifth Latin-American expedition, that being conducted by Llewelyn Williams, curator of economic botany, who is making a botanical survey in Venezuela, has not reported recently.

DEDICATION OF THE HORACE H. RACKHAM EDUCATIONAL MEMORIAL

THE Horace H. Rackham Educational Memorial of the Extension Service of the University of Michigan and the Engineering Society of Detroit was dedicated on January 28. The building was made possible by gifts to the university and to the society from the Horace H. Rackham and Mary A. Rackham Fund and from Mary A. Rackham. It was erected at a cost of $2,000,000 and is situated in the art center of Detroit.

President Alexander G. Ruthven accepted the building for the university. He pointed out that the facilities of the university wing of the memorial will be used to meet the educational needs of two groups, young people who are unable to spend years of continuous study at Ann Arbor and adults who desire to continue their education. He said:

No one with the ability to carry on advanced studies should be denied the opportunity through the accident of financial responsibility to pay the cost of the regular college courses. It is not expected that this unit will ever become a branch of the parent institution, extensively duplicating the educational facilities in Ann Arbor. The plan will be to offer here courses most in demand with the thought that they will serve the need both of those who seek merely a limited amount of training beyond the high-school level.

The two wings of the building, which is of white limestone, are owned separately by the university and the engineering society. They flank a central section which contains an auditorium with a seating capacity of 1,000 and a large banquet hall, both of which are available to either institution.

The facilities of the engineering unit include a dining room, a small auditorium, large lounge and social rooms, a library, meeting rooms for the seventeen affiliated societies of the society and offices for the executive staff.

Twenty-one classrooms in the university unit are capable of accommodating approximately 1,000 students at one time. Special classroom facilities are provided for radio and specialized speech courses, science, mathematics, engineering and the social sciences. There is in the central section a spacious library, which will be conducted as a branch of the general library of the university and which overlooks the Detroit Institute of Arts and the Detroit Public Library. The university unit also provides office and classroom space for the graduate curriculum in social work of the Institute of Public and Social Administration.

It is pointed out that centralization of the program of extension courses in the Detroit area will do much to unify and expand the program of the Extension Service, which for years has offered courses in churches, schools, "Y" buildings, hotel rooms and other scattered locations. Provision of office space in close proximity to the classrooms will also simplify administrative procedures. There was an enrolment for the first semester this year of more than 3,000 students.

ADVANCED INSTRUCTION AND RESEARCH IN MECHANICS AT BROWN UNIVERSITY

CONTINUING the work offered during the summer of 1941 and the present academic year, Brown University will offer opportunity for instruction and research in mechanics and allied branches during an eleven weeks period beginning on June 15, as well as during the next academic year. During the summer the emphasis will be on preparing for the present national emergency; during the academic year, attention will be directed primarily toward a long-range program of preparation in applied mathematics for university instructors and for research workers.

To review the work of the Summer School of 1941 and to make recommendations on a nation-wide basis, an evaluating committee, composed of eminent scholars in engineering, physics and mathematics, was appointed. This committee—consisting of Marston Morse, Institute for Advanced Study, *chairman;* Theodore von Kármán, California Institute of Technology; Mervin J. Kelly, Bell Telephone Laboratories; George B. Pegram, Columbia University, and Warren Weaver, Rockefeller Foundation—in its report stressed the present need for developing a program in applied mathematics and endorsed the experiment made at Brown University. It is also aiding in shaping plans for the future.

Courses are offered for the summer of 1942 under the direction of a distinguished faculty of eight. These include Professor Leon Brillouin, Professor Willy Prager, Dr. Stefan Bergman, Professor Ivan S. Sokolnikoff, Professor J. D. Tamarkin, Professor Willy Feller, Dr. Sergei A. Schelkunoff and Professor Richard von Mises. Under another program there will be lectures directed by Professor R. B. Lindsay. In addition there will be single lectures or short series of lectures by visiting experts, some stressing the practical side and others the theoretical. During the next academic year eight courses will be offered in addition to opportunities for research. Substantial fellowships will be available for selected students.

Because this work is supported by the Engineering, Science and Management Defense Training Program of the U. S. Office of Education, the Carnegie Corporation of New York and the Rockefeller Foundation, no fees will be charged. In the summer the participants will be limited to eighty in number, of which twenty will devote their time primarily to research; during the academic year the number will be limited to forty.

Information in regard to each of these programs may be obtained from the Dean of the Graduate School, Brown University, Providence, R. I.

THE RESEARCH COUNCIL ON PROBLEMS OF ALCOHOL

IN an outline of its program of its objectives, resources and progress, the Research Council on Problems of Alcohol makes a report of researches now in progress. These are:

A critical survey of all work completed to date on the effects of alcohol on the individual—by the College of Medicine of New York University, with a grant of $25,000 from the Carnegie Corporation.

A study of toxic factors in alcoholism—by the New York State Psychiatric Institute, with a grant of $1,500 from The American Philosophical Society. Minimum

value of services and facilities contributed by the institute—$2,200.

A study of the role of alcohol in liver cirrhosis—by the College of Medicine of New York University, with two grants, $2,100 and $1,500, from The Dazian Foundation for Medical Research. Minimum value of services and facilities contributed by the university—$7,200.

A study of reactions resulting from the ingestion of alcohol, for the ultimate purpose of discovering how a craving for alcohol is established—by the Phipps Psychiatric Clinic of Johns Hopkins University, with a grant of $1,800 from the council's research fund. Minimum value of services and facilities provided by the clinic—$3,750.

What happens to patients discharged as "cured" from institutions for alcoholics—by Columbia University, with a grant of $7,500 (for the first year) from the council's research fund.

The effects of maternal alcohol ingestions on the fetal cortex—by the University of Virginia Medical School, with a grant of $1,315 from the council's research fund. Minimum value of services and facilities provided by the Medical School—$500.

An informal survey of a town of 4,000 people to reveal the extent of alcoholism and the adequacy of measures now in use for its treatment—by E. M. Jellinek of the Laboratory of Applied Physiology of Yale University. This study is being carried on to provide for the experimental use of techniques being considered for a more extensive study.

GRANTS-IN-AID OF THE COMMITTEE ON SCIENTIFIC RESEARCH OF THE AMERICAN MEDICAL ASSOCIATION

THE Committee on Scientific Research of the American Medical Association has made grants-in-aid as follows:

T. T. Chen, University of California, illustrations of malarial parasites.

W. W. Cahill, Wayne University, Detroit, self-selection of food in relation to tumor growth.

Timothy Leary, Boston, Massachusetts, cost of extra illustrations in article on atherosclerosis.

Reginald Fitz, Boston, Massachusetts, the clinical beginning of hyperthyroidism.

I. M. Tarlov, Jewish Hospital, Brooklyn, plasma clot as nerve suture.

F. J. Braceland, Loyola University School of Medicine, Chicago, carbohydrate disturbances in schizophrenia.

A. M. Lassek, Medical College of the State of South Carolina, retrograde degeneration in pyramidal tract.

Charles W. Turner, University of Missouri, mechanism of lactation.

Robert P. Ball, Columbia University, roentgen pelvimetry.

A. McGhee Harvey, Vanderbilt University School of Medicine, Nashville, secretion of thymus gland.

John R. Paine, University of Minnesota, oxygen poisoning.

Hans Popper, Cook County Graduate School of Medicine, Chicago, vitamin A in tissue.

Wesley W. Spink, University of Minnesota, nutrition and immunology of staphylococci.

Oliver P. Jones, University of Buffalo, effect of antianemic principle on embryonic blood cells.

Enid Rodaniche, University of Chicago, chemotherapeutic agents on intestinal flora in infectious conditions.

Ben Vidgoff, University of Oregon, morphology of endocrine and secondary sex organs in male white rat.

Daniel J. Glomset, Des Moines, Iowa, cardiac conduction.

L. R. Cerecedo, Fordham University, New York, vitamin B deficiency in rats and mice.

Catharine Macfarlane, Woman's Medical College of Pennsylvania, Philadelphia, periodic pelvic and breast examination.

Peter P. H. de Bruyn, University of Chicago, osteogenic substances in laying birds.

THE FIRST WESTERN MEETING OF BIOMETRICIANS

ON the initiative of Dr. C. I. Bliss, chairman of the Committee of the Biometric Section of the American Statistical Association, a committee of biologists and statisticians was appointed recently to organize a meeting of western biometricians. Such a meeting was held on the Berkeley campus of the University of California on December 29 and 31, 1941. The theme of the meeting was: "The Potential and Actual Contributions of Statistics to the Solution of Biological Problems." Sessions were held concurrently with those of the two national entomological societies whose members have shown considerable interest in applications of mathematical statistics. A joint session was held with these two groups in San Francisco on the afternoon of December 30.

The committee that arranged this first western meeting of biometricians interpreted the word biometry in a very broad sense and encouraged the attendance of biologists and mathematicians from as many fields as possible. Six separate sessions were held, each devoted to a general field. These included: (1) botany—population studies, plant breeding and genetics; (2) general biology—bacteriology, irradiation by x-rays and by neutrons; (3) mathematics—statistical techniques; (4) entomology—population studies and sampling problems; (5) forestry—growth, genetics and sampling problems.

Twenty-four papers were presented in all and many of them created lively discussions. The meeting was well attended by both biologists and mathematicians, the former predominating. This testified to the widespread interest of biologists in the application of statistical methods in their research. The growing usefulness of statistics in biology was clearly evident in the tone of the meeting. It was felt that similar western meetings called at regular intervals, perhaps conjointly with the meetings of the Pacific Coast Section

of the American Association for the Advancement of Science, would be useful both to the biologists and to biologically-minded mathematicians and physicists.

At a business meeting called during the second day it was resolved to set up a permanent organization, to be known as the Western Society of Biometricians, which may become affiliated with the American Association for the Advancement of Science, with the American Statistical Association and perhaps with other organizations. A committee was elected to draw up the form of the permanent society. The members of the committee were selected to represent all fields of biology and mathematics. The following officers have been elected:

Chairman: J. Neyman (Mathematical Statistics); *Vice-chairmen:* E. B. Babcock (Genetics); R. T. Birge (Physics); E. C. Tolman (Psychology), all of the University of California, Berkeley; *Secretaries:* E. R. Dempster (Genetical Effects of Irradiation), also of the University of California at Berkeley, and A. Hormay (Range Management), California Range and Forest Experiment Station at Berkeley.

The organization of a second meeting, where the form of the new society could be discussed and voted upon, was left to this committee. In addition, the committee was directed to consider the possibilities of establishing a journal for the publishing of biological papers involving the application of mathematics to biological problems. Such a journal is needed in order to fill the gap between mathematical publications and the journals of biology. No such journal has been published in this country up to the present time. The idea of the new journal originated with the Committee of the Biometric Section of the American Statistical Association, and was heartily approved by those in attendance at the first western meeting in Berkeley. Any one interested in the new society is invited to communicate with members of the organizing committee.

SCIENTIFIC NOTES AND NEWS

THE annual general meeting of the American Philosophical Society will be held in Philadelphia on April 23, 24 and 25. The sessions on Thursday, April 23, will be devoted to a symposium on recent advances in American archeology in which fifteen leaders in that field will take part. The Franklin Medal Lecture will be given on that evening by Dr. Sylvanus G. Morley on the work of the Carnegie Institution in Central America and Mexico. Dr. James Rowland Angell will deliver the Penrose Memorial Lecture on Friday evening, April 24, on the general subject of education in a world at war.

A SPECIAL cable from London to *The New York Times*, dated February 21, reports that the Faraday Medal of the Council of the British Institution of Electrical Engineers has been awarded to Dr. Peter Kapitza in recognition of his contributions to science in the generation and utilization of intense magnetic fields. Dr. Kapitza is director of the Institute of Physical Problems at the Moscow Academy of Sciences. Formerly he was assistant director of magnetic research at the University of Cambridge.

PRESENTATION of the gold medal of the Radiological Society of North America was made at the recent San Francisco meeting to Edith H. Quimby, "in recognition of her work on dosage and filtration." Since 1932 Mrs. Quimby has been physicist at the Memorial Hospital for the Treatment of Cancer and Allied Diseases, New York.

A. B. HOEN, president of the firm of A. Hoen and Company, lithographers, Baltimore, has been elected an honorary member of the American Geographical Society of New York. The honor was conferred on Mr. Hoen in recognition of the contributions that his firm and he personally have made to the development of the science and art of fine map reproduction in the United States.

HAROLD S. OSBORNE, plant engineer in the operation and engineering department of the American Telephone and Telegraph Company, New York, has been nominated for the presidency of the American Institute of Electrical Engineers.

FRANCIS W. PENNELL, curator of plants of the Academy of Natural Sciences of Philadelphia, has been elected president of the American Society of Plant Taxonomists.

DR. FRANCIS S. SMYTH, professor of pediatrics at the Medical School of the University of California, has been appointed dean. The post has been vacant since the retirement in December, 1939, of Dr. Langley Porter.

PROFESSOR DAVID L. ARM, of the Iowa State College, has been appointed head of the department of mechanical engineering. He succeeds Mark P. Cleghorn, who will continue his work as professor.

G. M. RIDENOUR, formerly associate professor of sanitary engineering at Pennsylvania State College, has been appointed associate resident lecturer on public health engineering at the School of Public Health of the University of Michigan.

THE staff of the department of psychology of the

Louisiana State University has undergone several changes in the past few months. Dr. Wayne Dennis has been appointed professor of psychology and head of the department; Dr. James H. Elder has been appointed assistant professor of psychology to succeed Dr. Harry M. Capps, who died on January 17; Dr. Alan D. Grinsted has leave of absence while on duty as a lieutenant in the U. S. Navy.

DR. A. PACKCHANIAN, who during the last six years has been connected with the National Institute of Health of the U. S. Public Health Service, has resigned to become associated with the School of Medicine of the University of Texas at Galveston. He will continue research in bacteriology and tropical medicine.

DR. ERNEST W. REID, of Pittsburgh, who has been assistant chief, has been appointed chief of the Chemicals Branch of the Division of Materials of the War Production Board. He takes the place of Dr. Edward R. Weidlein, director of Mellon Institute, who will continue as senior consultant. Dr. Weidlein has been devoting part of his time to the branch, with his efforts centered recently on development of the synthetic rubber program. He will continue this responsibility for the Materials Division.

DR. AMOS CHRISTIE, associate professor of pediatrics at the Medical School of the University of California, San Francisco, has been appointed assistant director of medical and health service of the American Red Cross, with headquarters in Washington.

DR. ROBERT CUSHMAN MURPHY, of the American Museum of Natural History, has been elected a councilor of the American Geographical Society.

C. F. RASSWEILER, director of research of the Johns-Manville Corporation, has been appointed a vice-president of the company. He will continue in charge of research and development activities.

FOLLOWING the death of Senator Alva B. Adams of Colorado, Senator Carl A. Hatch of New Mexico was named on January 15 to take his place as chairman of the Senate Committee on Public Lands and Surveys. This committee has charge of all Senate bills relating to national parks.

PROFESSOR THEODORE H. MORGAN, head of the department of electrical engineering of the Worcester Polytechnic Institute, Worcester, Massachusetts, has been called to the U. S. Office of Education at Washington as principal specialist in engineering education. His work will involve responsibility for the administration of the educational aspects of the national engineering defense training program in colleges and universities, including the development of intensive courses designed to fit engineers for specialized positions in defense industries involving all fields of engineering. He has been granted leave of absence and will reside in Washington.

Nature states that Sir John Russell, director of the Rothamsted Experimental Station, has been appointed adviser to the Soviet Relations Branch of the Ministry of Information. When carrying out research in the agricultural sciences, Sir John came into close contact with Soviet men of science and has traveled widely in the U.S.S.R.

NOMINATIONS to the council of the American Association of Museums for the three-year term 1942-45 have been made by the council as follows: Henry Butler Allen, director of the Franklin Institute, Philadelphia; Andrey Avinoff, director of the Carnegie Museum, Pittsburgh; Alfred H. Barr, Jr., director of the Museum of Modern Art, New York; Charles M. B. Cadwalader, director of the Academy of Natural Sciences of Philadelphia; Grace L. McCann Morley, director of the San Francisco Museum of Art; Arthur C. Parker, director of the Rochester Museum of Arts and Sciences; Laurance P. Roberts, director of the Brooklyn Museum, New York; Carl P. Russell, supervisor of interpretation, National Park Service, Washington; Paul J. Sachs, associate director of the Fogg Art Museum, Cambridge, and Alexander Wetmore, assistant secretary of the Smithsonian Institution, Washington.

DR. OTIS W. CALDWELL, general secretary of the American Association for the Advancement of Science, spoke on February 26 at 7:30 P.M. at Members Night of the American Institute, New York. His subject was "Text-book Science."

DR. ALBERT F. BLAKESLEE, of Cold Spring Harbor, N. Y., last year president of the American Association for the Advancement of Science, delivered on February 19 the annual Phi Beta Kappa lecture at the College of Wooster on "Personality in Relation to Science and Society." He also addressed the students on "The Scientific Method in Every-day Life," and spoke to the staff of the Ohio Agricultural Experiment Station and a genetics group at the college on "Control of Evolution in Datura."

THE seventh annual Hughlings Jackson memorial lecture of the Montreal Neurological Institute will be given on February 27 by Dr. Edgar D. Adrian, professor of physiology at the University of Cambridge, Nobel laureate in medicine in 1932. He will speak on "Sensory Areas of the Brain."

DURING the period from February 23 to March 14, Dr. P. W. Bridgman, Hollis professor of mathematics

and natural philosophy at Harvard University, is delivering Sigma Xi lectures dealing with the problems and techniques of high pressure at the following institutions: the Iowa State College, the University of Minnesota, the University of Wisconsin, Purdue University, the University of Cincinnati, the Carnegie Institute of Technology, the University of Illinois, the Ohio State University, the Pennsylvania State College, Swarthmore College, Rutgers University, Yale University, the University of North Carolina, the Louisiana State University, Tulane University, the University of Texas and the Rice Institute.

A SERIES of three public lectures entitled "Our Ancestors, Ourselves, Our Descendants" has been arranged at the Woman's Medical College of Pennsylvania. On January 23, Professor R. Ruggles Gates, of the Marine Biological Laboratory at Woods Hole, Mass., delivered the first lecture. Professor Laurence H. Snyder, of the Ohio State University, will give the second lecture on March 27, and Professor Earnest A. Hooton, of the department of anthropology of Harvard University, will give on April 24 the last lecture.

A SERIES of fourteen Thursday evening seminars on "Biologically Active Substances" will be conducted this winter at the Physiological Laboratories of Clark University. Those in charge of the seminars are: Dr. Kenneth Thimann, Harvard Biological Laboratories; Dr. Gregory Pincus, Clark Physiological Laboratories; Dr. E. B. Astwood, Harvard Medical School; Dr. Arturo Rosenblueth, Harvard Medical School; Dr. G. H. Parker, Harvard Biological Laboratories; Dr. Valy Menkin, Harvard Medical School; Dr. George Wald, Harvard Biological Laboratories; Dr. Mark Graubard, Clark Physiological Laboratories; Dr. Elmer Stotz, Harvard Medical School; Dr. Kurt Stern, Yale Medical School; Dr. Hudson Hoagland, Clark Physiological Laboratories; Dr. Robert S. Harris, Massachusetts Institute of Technology; Dr. H. J. Muller, Amherst College; Dr. M. L. Anson, The Rockefeller Institute.

THE Civil Service Commission is seeking metallurgists for work in Government navy yards, arsenals and other war agencies. The positions pay from $2,000 to $5,600 a year and will last in most cases for the duration of the war. Sending application forms, obtainable in any first- or second-class post office, to the Commission in Washington, D. C., is all that is necessary to be considered for these positions. Experience in metal-working industries with fabrication processes such as welding, die-casting, heat treating, x-ray testing and metallographic work is particularly desired, but not necessary for all positions. College training in metallurgy or college training in other subjects and one year's experience in metallurgy will qualify for positions paying $2,000 a year. For the higher salaried positions, some industrial experience or graduate study, in addition to a bachelor's degree, is required. The positions are in Washington, D. C., and in Government war establishments throughout the country.

ALUMNI of Bucknell University have organized the Bucknell Alumni Research Foundation and have incorporated it as a non-profit organization. Its immediate purpose is to utilize the results of the researches of Dr. William H. Eyster, who has been made research professor of genetics. Dr. Eyster will, in the future, devote most of his time to a study of the genetics and breeding of economically important food and ornamental plants.

THE third annual symposium of the Society for the Study of Growth and Development was advertised in SCIENCE of January 2 as $3.00 to members of the society. The price should have been $3.00 to nonmembers of the society. Members, of course, receive a copy free.

THE eighty-first national meeting of the Electrochemical Society will be held at Nashville, Tenn., from April 15 to 18. Plans for the meeting are being carried out by Professor J. M. Breckenridge and his committee. There will be two symposia, one on "Electric Furnace Reactions," in charge of Dr. John D. Sullivan, of Battelle Institute, Columbus, and the other on "Corrosion," in charge of Dr. R. M. Burns, of the Bell Telephone Laboratories, New York City.

THE Midwestern Psychological Association will hold its seventeenth annual meeting at Hotel Statler, St. Louis, Mo., on Friday and Saturday, May 1 and 2, under the presidency of Dr. J. P. Porter. The title of his presidential address will be "Psychology and the Functional Integration of Human Behavior." The members of the department of psychology at Washington University will act as hosts, with Dr. J. P. Nafe as chairman of the local committee. On account of the considerable distance of the university from housing facilities, all meetings will be held at Hotel Statler, the headquarters.

THE Association of Southeastern Biologists will hold its sixth annual meeting at Miami, Fla., April 16, 17 and 18, with the University of Miami as host, The official hotel will be the Antilla, Coral Gables, at $1.50 per day. The president, A. S. Pearse, Duke University, will address the association on marine biology in the Southeast. The first day of the meeting will be devoted to a marine trip and a field trip to the Everglades. Information regarding the trips can be obtained from Professor Jay F. W. Pearson, of the

University of Miami. Abstracts of papers to be presented must be filed with the secretary, Donald C. Boughton, U. S. Regional Laboratory, Auburn, Alabama, not later than March 31.

THE second American Congress on Obstetrics and Gynecology, sponsored by the American Committee on Maternal Welfare, will be held in St. Louis from April 6 to 10. The program will include general assemblies and individual group meetings on medical, nursing, public health and institutional administrative problems relating to the factual and scientific aspects of maternal and infant care.

DISCUSSION

A YEAR IN AN AMERICAN UNIVERSITY

IT is always with the greatest of pleasure that I recall the time I spent in the United States in 1928–29 as a visiting professor of colloid chemistry in the University of Wisconsin, Madison. Madison is a charming little town lying in the midst of the golden fields of the Middle West and surrounded by numerous lakes and forests. The locality strongly resembles that of the Valdai Hills or Lake Seliger, the favorite vacation spots of the residents of Moscow and Leningrad.

Almost the whole of Madison is permeated with the life of the university, and the university grounds are the real heart of the city. There are many such towns in England and Holland, and once Germany, too, had such towns, but that was before the tempest of madness dispelled the traditions of German learning.

Particular attention was concentrated on colloid chemistry in the University of Wisconsin, and this chair was occupied in turn by a number of professors invited from other universities and even from other countries. Nowhere is this excellent form of international scientific collaboration practiced so widely as in the United States. Besides teaching, I had the opportunity, while in Madison, of engaging in certain experimental researches on various problems of electrochemistry. What especially amazes the foreigner in an American laboratory is the ability to get along with a very small service staff and with a modest supply of apparata and reagents. The necessary orders are put through without any formalities and thanks to the high level of the American laboratory supplies industry and the fact that standard spare parts for instruments are always on sale, these orders are very easily filled. American students very quickly grasp and carry out the idea of experimental work, for they come of a people accustomed to automobiles and radios from childhood.

Another attractive feature of the University of Wisconsin was its democratic traditions and the interest its members showed in the Soviet Union. Every new person I met followed up the traditional first question, "How do you like this country?" with questions concerning the life of the Soviet Union, its organization and aims. The American does not put these questions in a general form. On the contrary, he tries to build up a picture for himself on the basis of concrete details. I remember that when I was asked to speak on the Soviet Union at the faculty of the chemistry department the questions put to me sometimes concerned minor everyday matters, which, however, helped the audience form a tangible idea of life in the Soviet Union.

In general the year I spent in Madison is one of the most pleasant years of my life. The only thing that worried me at first was the fear that my English would be unintelligible to my students. These fears, however, were soon dispelled; as explained to me with the characteristic outspokenness of the American students, since I always made the same mistakes my hearers soon readily grew accustomed to them.

My year in Madison also gave me the opportunity to visit a number of other American universities and laboratories and to become acquainted with many prominent American chemists. In the General Electric laboratories in Schenectady I had the great pleasure of meeting Dr. Irving Langmuir, who, in my opinion, has had more influence than anybody else on the modern development of physical chemistry. Especially that field which has taken most of my attention, the study of surface phenomena, is endlessly indebted to the brilliant and versatile gifts of this scientist. I remember very well how, at the beginning of my career, I used to impatiently await every new work of Langmuir's. The last time I saw his signature under a printed text was but a few weeks ago. It stood under an appeal addressed by American scientists and writers and calling for a fight against Nazism.

At the invitation of Professor J. W. McBain, I delivered a lecture at Stanford University, amidst the cactuses and palms of California. We had a long discussion then about the structure of surface layers, but just now I should like to remember Professor McBain not only as an outstanding scientist but as a man who has given a great deal of effort to consolidating the ties between American and Soviet science. On my way back to Moscow from America I stopped in Berlin. This was in the summer of 1929. German science was still in existence then, and on the quiet streets of Dahlem people spoke of scientific theories

and new discoveries and not of killing and destruction. In the Kaiser Wilhelm Institute für physikalische Chemie, directed by the famous Friedrich Haber, I met Professor N. Freundlich, from whom we all more or less learned colloid chemistry. He invited me to remain and work awhile in Germany, but I was in a hurry to get home.

All this now seems to be a dream from long ago. Haber and Freundlich have died in exile. The Germany of to-day does not offer us joint scientific work but the destruction of our cities and the physical extermination of their populations. All our thoughts are turned to the assistance of our country. And in this fierce fight which we are waging for ourselves and for all humanity, we are glad to know that we have behind us all the might of the great American nation.

A. FRUMKIN

NEON LIGHTS

IN the December 19, 1941, issue of SCIENCE, there appears a note entitled "Extra Strong Heliotropic Effect of Neon Lights." The writer points out that insects have been observed to collect around neon lights to a greater extent than around "white lights." He then suggests that the "neon lights may emanate invisible rays which connect with the antennae of various insects and pull them to its source." The belief is implied that the insect eye is sensitive only to visible radiation, that is, wave-lengths to which the human eye is sensitive (approximately 3,900 to 7,200A).

Experiments by Bertholf on the honey-bee[1] and *Drosophila*[2] show that in these two insects sensitivity to wave-lengths in the near ultraviolet is far greater than sensitivity to those wave-lengths visible to the human eye. The sensitivities of these insects have maxima near 3,600A several times the sensitivity to any wave-lengths in the visible; and there is general high sensitivity between 3,000 and 4,000A. The spectrum of neon shows a number of strong lines in this region, whereas the spectra of tungsten filament lamps, presumably the source referred to as "white lights" by the writer, is weak in this region. Even without an estimate of relative intensities one might expect that these insects, both of which are positively oriented by light, would collect in greater concentration about neon lamps than about tungsten filament lamps. It is reasonable to assume that the eyes of many other insects have spectral sensitivities similar to those of the honey-bee and *Drosophila* and would behave in similar fashion. Lacking complete knowledge on this point and with no estimate of the relative intensities of the sources, no final explanation of the writer's observation can be given, but there seems no reason to postulate that any organ other than the insect eye is involved.

It seems appropriate to call attention here to the fact that many interpretations of behavior of lower organisms have been based on the assumption that their light receptors are strictly comparable to the eyes of man. Accurate information on the photoreceptors of invertebrate organisms is more scanty than could be desired, but, nevertheless, many instances of mystifying behavior of organisms in light fields may be quite simply explained if spectral sensitivity and visual acuity are taken into account.

HAROLD F. BLUM

NATIONAL CANCER INSTITUTE,
NATIONAL INSTITUTE OF HEALTH,
U. S. PUBLIC HEALTH SERVICE

[1] L. M. Bertholf, *J. Agric. Research* (1931) 42, 379; 43, 703.

[2] L. M. Bertholf, *Ztschr. vergleich. Physiol.* (1933) 18, 32.

GALENA IN CONCRETIONS OF POTTSVILLE AGE

THE writer is interested in the article written by Alfred C. Lane in the issue of SCIENCE of November 14, 1941, concerning the occurrence of galena in sedimentary rock. Lane calls our attention to the fact that sedimentary galena from Joplin, Mo., has a relatively high proportion of isotopes which may be of radiogenic origin. He urges that galenas from sedimentary formations be collected and kept for further scientific research, and the Committee on Measurement of Geologic Time be informed about it.

Near Marshallville, Ohio, in a railroad cut near that village, is an excellent exposure of the unconformity between the Mississippian sandstone and the basal Pennsylvanian, known as the Pottsville. Not far above the unconformity, in a black, bituminous, thinly laminated shale, occur numerous clay iron-stone concretions of the septarian type. These contain an association of minerals similar to that in the lead and zinc deposits of the Mississippi Valley. In addition to galena are found sphalerite, barite and pyrite. Sphalerite occurs in greatest abundance and barite is quite common. Galena is rare in occurrence and it required the cracking of large numbers of concretions to find one crystal, which is embedded in the concretion and measures about one quarter inch long and one eighth inch wide.

KARL VER STEEG

COLLEGE OF WOOSTER

A PURE NITROGEN NATURAL GAS WELL

WHAT is believed to be the first pure nitrogen natural gas well ever to be discovered in the United States, in so far as the writer has been able to ascertain, has been discovered at a shallow depth in eastern Wyoming, during the past season.

In the course of drilling a well for water on the

W. H. Cross ranch, near the southern rim of the Powder River Basin, at a depth of only 156 feet, the bit penetrated a sand member containing a non-inflammable gas, under considerable pressure, so the well was shut down for a check and testing.

Warren D. Skelton, Wyoming state mineral supervisor, took a sample of this gas, and turned it over to the U. S. Geological Survey testing laboratory, in Casper, Wyoming. The analysis made by J. G. Crawford, chemist there for the Geological Survey, shows this sample to be 100 per cent. pure nitrogen gas. In a letter concerning this unusual occurrence to the writer, Mr. Skelton states: "I am certain the sample was in good shape for analysis when taken, as the gas was allowed to flow through the tube for some time before the connections were closed and the sample taken confined."

The official report furnished to me by the state mineral supervisor shows that this nitrogen gas developed a rock pressure of eleven pounds in ten minutes. As the top of the sand was barely penetrated, according to information furnished by the drillers, it is probable that this does not represent the total rock pressure present here. It has been the writer's observation that actual top pressures may take much more time than this to develop, with other natural gas wells of relatively low pressures, even when the sands have been fully penetrated by the drilling bit, particularly where such sands tend to be "tight," *i.e.*, of low porosity, or partially cemented up. Consequently, a considerable pressure of this nitrogen gas may be present in this formation and locality. The well was shut down and closed.

Because of the possible use of this remarkable natural gas for present war emergency purposes, it seems important to call general attention to its existence at this time.

HAROLD J. COOK,
Consulting geologist

AGATE, NEBRASKA

ADVERTISEMENTS IN SCIENCE

I HAVE just received the issue of SCIENCE for February 6, 1942. I wish to raise again a question of which I spoke once before, namely the small amount of report and discussion of the scientific matters of the annual meeting and the large amount of advertising.

I check 23 pages of reports and accompanying discussions, and 65 pages of advertising. The reports and discussions are preceded by a little more than half of the advertising. When I first picked up this issue its size gave me the impression that we would have a more than usually full account of the meetings. Examination showed that my first impression was decidedly wrong. Indeed, as I turned the pages looking for the reports, I was disturbed and much disappointed in being forced to the conclusion that the science meetings, so far as the reports go, are merely the agencies for carrying a huge amount of paid-for advertising. I am fully aware that the advertising is what pays mostly for the publication, as well as for profits beyond costs. Although the magazine is the property of the editor it is listed as an official organ of the American Association for the Advancement of Science and undoubtedly many members think of the American Association for the Advancement of Science and the magazine as closely related in policies. Hence my brief comments from which I omit a good many points which occur to me.

OTIS W. CALDWELL

As Dr. Caldwell's point of view may be shared by other members of the American Association for the Advancement of Science, it seems desirable to give an explanation of the situation. SCIENCE issues one special number a year and selects the one containing the report of the annual meeting of the association which is sent to all members of the Association and to some scientific men who should become members. Consequently, the issue for February 6 had a circulation of 30,000 copies.

This provides an attractive opportunity to publishers of scientific books, makers of scientific instruments and dealers in scientific supplies to reach practically all the scientific men of America through the insertion of a single advertisement. If such an advertisement were inserted in each of the special scientific journals the cost would be perhaps fifty times as much. There is no advance in charges for advertisements in the special issue, which has twice the usual edition. Consequently, profits to the journal are much smaller than in the regular issues. It is an opportunity for advertisers to come in contact with scientific men and to demonstrate their interest in research work. The special issue of SCIENCE is welcome to scientific men for the report of the annual meeting of the association and because the advertisements are of interest to them. The number can be kept through the year as a summary of the work done and as a directory of what is being accomplished by publishers and manufacturers to cooperate in work for the advancement of science. For this end publications and apparatus are as essential as the work of scientific men.

The special issue contains the same number of reading pages as the regular issues of the journal, which prints two volumes a year of about seven hundred pages each. In 1940 the number of pages of reading matter in the first volume was 704; in the second volume it was 698. This is equal to the contents of twenty books which might sell for three dollars each. Members of the American Association pay three dol-

lars for the annual subscription. There are but few journals—perhaps no scientific journals—of the size of SCIENCE that are supplied at such a moderate rate. The subscription to *Nature* is £4"10s"0d.

The expenses of SCIENCE, according to the audit report of 1940 (the report for 1941 is not yet ready), adding $10,000 as the estimated value of the editorial work, are $68,439. In 1941 there were 15,185 subscribers, making the cost of supplying the journal to each subscriber $4.51. It is possible to supply the journal to members of the association for three dollars each only on account of libraries and other subscribers who pay the regular subscription price of $6.00, and principally on account of receipts from advertising, which in 1940 amounted to $33,297.

These advertisements are not only of value to advertisers, but are also useful to readers of the journal. One of the most distinguished scientific men in America paid a doubtful compliment to SCIENCE by writing that he found the advertisements the most interesting and useful part of the journal. Great care is taken by the editor to admit to the advertising pages only announcements that are regarded as promoting the advancement of science. Not only does SCIENCE contain no advertising of tobacco and liquors, but there are no announcements of automobiles and other products of scientific invention which might be regarded as of interest to scientific men. Every effort is used to make the advertisements informative and not primarily competitive. Advertisements are not accepted that make extravagant claims, and advertisers cooperate with the journal in presenting their announcements in a scientific and dignified form, such as is in place in a journal such as SCIENCE.

SCIENCE has been the official journal of the American Association for the Advancement of Science since 1900; during this period the membership of the association has increased from about 1,200 to more than 23,000. Since the agreement of 1938, SCIENCE has been the property of the association, though the present editor retains control until he dies or voluntarily relinquishes it. The control will then be taken over by the association and will rest in the hands of members of the executive committee and of the council. Like the present editor they will doubtless realize the importance for the advancement of science in America of intimate and cordial relations between scientific workers and those who publish their work and those who supply them with the necessary apparatus and supplies. Scientific progress is the joint product of research men and manufacturers. This is notably the case in the great industrial laboratories on whose knees lies the future of science and civilization.

EDITOR

SCIENTIFIC BOOKS

RESEARCH AND STATISTICAL METHODOLOGY

The Second Yearbook of Research and Statistical Methodology Books and Reviews. Edited by Oscar Krisen Buros. xxii + 383 pages. Highland Park, New Jersey: The Gryphon Press. 1941. $5.00.

IN 1625 Francis Bacon, in his essay "Of Studies," wrote: "Some books are to be tasted, others to be swallowed, and some few to be chewed and digested; that is, some books are to be read only in parts, others to be read, but not curiously, and some few to be read wholly, and with diligence and attention." Had he lived to-day, he might have added that some books ought not to be read at all. At no time in the past has there ever been such a need for guidance in selecting books for reading, study or reference. Presumably, book reviews are written to provide such advice. If this is the case, then a reviewer is placed by his role in a position of trust; especially when his prominence is such as to give special importance to his opinions. It is regrettable, therefore, when prominent individuals write inconclusive reviews of books the subject-matter of which is well within the domain of their proficiency. It is likewise unfortunate when reviewers venture outside their competence. Nowhere are these regrettable occurrences more prevalent than in the reviewing of books on statistical theory and methodology. Furthermore, the consequences are serious, for the majority of readers and users of statistical text-books and manuals are not qualified to judge the validity, accuracy or limitations of the material before them. In selecting a book on statistical theory or methodology, it is often necessary at the present time to examine several reviews of the same book. This comparison of evaluative statements appearing in diverse journals and periodicals is greatly facilitated by the book under discussion here.

"The Second Yearbook of Research and Statistical Methodology Books and Reviews," like the first volume of this series,[1] is a collection of book review excerpts. By the editor's count, " 'The Second Yearbook' contains one thousand six hundred and fifty-two review excerpts from two hundred and eighty-three journals compared to six hundred and thirty-five review excerpts from one hundred and thirty-one journals in the first volume." Only one journal, *Economica,* did not grant permission to excerpt its reviews; suitable

[1] "Research and Statistical Methodology Books and Reviews of 1933–1938." Edited by Oscar Krisen Buros. New Brunswick, N. J.: Rutgers University Press. 1938. $1.25.

reviews in this journal consequently have been indexed but not excerpted. The journals utilized represent a wide variety of fields: accountancy, actuarial science, agriculture, anthropology, business, biology, economics, education, engineering, entomology, eugenics, forestry, general science, genetics, mathematics, medicine, philosophy, physics, plant pathology, political science, psychology, public health, sociology, statistics, veterinary science, and others. A directory of these periodicals is provided for the first time, and in it are listed the editor's name, the location of the editorial offices, the number of issues per year, the price, the name of the organization of which the journal is the official organ, etc. Other new features are a publishers' directory and the addition of authors' names as catchwords in the running heads at the top of each page. As the books are arranged in alphabetical sequence according to authors, the last-mentioned feature greatly facilitates reference to the books by a particular author. The index of names provided does not distinguish in its references between books and book reviews by the individual concerned and could be made more useful by printing in different kinds of type the numbers which designate books and book reviews by a given individual. An index of titles, a classified index and a publishers' index and directory are provided also.

"The Second Yearbook" lists three hundred and fifty-nine books written in English and published in 1933 or since, the great majority accompanied by at least one review excerpt. About one third of these were listed previously in the first volume and are included again in accordance with the policy to continue listing books in successive yearbooks as long as new reviews appear. In such cases references are given to the reviews appearing in the first volume. The excerpts in "The Second Yearbook" are longer and more informative than those in the first volume of this series. Other improvements are a better format, larger type and a more natural numbering system—the curious system employed in the first volume was bewildering to many users. "The Second Yearbook" is on the whole a marked improvement over the first of the series. The editor seems to have profited from the reviews of the first volume, excerpts from these reviews being included in the present volume.

The objectives of this yearbook series in its present form are listed in the preface as follows:

> (a) To make students and teachers of statistics more keenly aware of the inadequacy of much of what is now presented in text-books and classes despite the fact that such statistical techniques are incorrect, inefficient, and obsolete. (b) To help students, teachers, and librarians to select text-books with greater discrimination. (c) To point out to students and teachers the weak and strong points of particular books. (d) To assist more advanced students in keeping abreast of modern developments in monograph and textbook writing and criticism. (e) To encourage research workers to consider and examine methodology books intended for workers in other fields and also books on general history of science, scientific method, and the social relations of science. (f) To emphasize that there are usually marked differences of opinion even among the more advanced students of statistical theory in their appraisal of a particular book. (g) To indicate the vast extension of fields in which statistical techniques are being found useful and necessary. (h) To discourage the writing and publication of stereotyped text-books written by persons ignorant of modern developments in statistical theory. (i) To make readily available important and provocative statements which, though appearing in book reviews, have considerable value entirely apart from a consideration of the book under review. (j) To improve the quality of reviews by stimulating editors to take greater pains to choose competent reviewers who have the industry and the courage to contribute frankly critical reviews following a careful study of the book being reviewed. (k) To improve the quality of book reviews by stimulating reviewers "to take their responsibilities more seriously" by refusing to review books which they cannot, or will not, appraise competently and honestly.

In pursuing these objectives the editor of "The Second Yearbook" has been limited by the extent to which the reviewers themselves made these their goals—he could only quote from what was before him. "The quotations represent the critical portions of all reviews which could be located, even though some of these reviews seemed to have been written by persons who either were incompetent to appraise the book under review or were unwilling to speak frankly. [The aim has been] to present in an unbiased manner the evaluative comments contained in all reviews which [could be located]. The amount of space devoted to excerpts for a given book is in direct proportion to the number of evaluative reviews located and not necessarily to the importance of the book." As a result of this editorial policy, "The Second Yearbook" is somewhat encumbered with inconclusive excerpts from inconclusive reviews. While this may be all right from the viewpoints of objectives (j) and (k), it greatly dulls the effectiveness of "The Second Yearbook" as a guide in the selection of books, *i.e.*, from the viewpoints of objectives (a) to (c). The present reviewer feels that the editor would do well in the preparation of future yearbooks to strive for maximum guidance in the selection of books, by including only the most informative and provocative statements, leaving objectives (j) and (k) to be attained indirectly through his presentation of examples of good reviewing.

The excerpting seems to have been done without noticeable bias. From a comparison of numerous excerpts with the original reviews, it can be said that on the whole the excerpts faithfully reflect the

opinions of the original reviewers relative to the authors' choices of subject matter and their presentation of it. By making available in one place some really evaluative statements originally appearing in very diverse journals, the editor has rendered a great service to all who try to select the best from the mass of current literature on statistical theory and methods. Incidentally, from a comparison of some of the reviews presented here, the present reviewer wonders whether it might not be desirable in certain instances to have reviews jointly written by an expert on the theory involved and a person experienced in the field of application.

While the excerpts in "The Second Yearbook" provide a good summary of the reviewers' opinions of a given book, they generally fail to give an adequate guide to its contents, even when all excerpts for this same book are viewed collectively. In most instances the original reviews contained a listing of the contents, but these portions were generally omitted in the excerpts. Since such information is most essential for objectives (a) to (c), the present reviewer feels that the editor should devise some scheme for including this information in future yearbooks.

On account of its cost, which really is not excessive considering the work involved, it is unlikely that "The Second Yearbook" will find its way into the libraries of all persons interested in statistical theory and methodology. On the other hand, it should be available in departmental libraries of all departments employing statistical methods in their research, and, on account of its fairly comprehensive listing of books on history of science and scientific method, it should be a useful volume in almost every scientific library. As noted above, only books written in English are included in the present volume, but the editor comments, "If 'The Second Yearbook' is well received, foreign-language books will probably be included in the next yearbook." The continuation and improvement of this yearbook series are thus placed squarely on the shoulders of the scientific public.

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CLINICAL PELLAGRA

Clinical Pellagra. By SEALE HARRIS. 494 pp. 66 figures. St. Louis: C. V. Mosby Company. 1941.

THIS book is the first on pellagra by an American author in more than twenty years—a period during which there has been greater progress in our knowledge of the disease than in all the rest of the history of pellagra. It therefore covers a most important period for the reader who has not closely followed the technical literature.

The author has been closely connected with the pellagra problem in this country from the discovery of the endemic disease here to the present time, although most of his work was done in the earlier period. The book is primarily one for the clinician, and the sections covering the symptoms and treatment are the most valuable. The book is beautifully illustrated, thus enhancing its value to those interested in the deficiency diseases. The number of excellent photographs of the various lesions of pellagra constitute the best published collection.

The chapters written by the author's collaborators lend much weight to the work and present the views of other centers. The chapter on Pellagra in Childhood by Dr. Katharine Dodd deals with a phase of the disease which previously has been greatly neglected. The presentation of the research work of the investigators at the University of Georgia and Duke University adds materially to the completeness of presentation but necessarily results in some repetition.

Much of the first three sections of fourteen chapters is taken up with a consideration of former theories about the etiology of pellagra, which have now been discarded. The chapters on history and epidemiology are interestingly written and he writes very entertainingly on the history of the disease in this country. His easy style and personal experiences add an attractive flavor to this section of the book, which is infrequently found in medical books.

The chapter on pathology is exceptionally short (9 pages) and sketchy in comparison with the other portions of the book.

Dr. Harris includes an unusual section entitled, "Plagues from Devitaminized Foods," which is a philosophical discussion on the wide use of refined foods in this country. He contends that the vitamin fad is not good for the general population and his insistence that proper dietary habits would solve the problem is entirely sound from a theoretical point of view.

The author frankly states that many of the ideas expressed are his own and not always in accord with other observers. He states that alcohol is one of the important factors in the causation of pellagra because of its hepatoxic action and the consequent disturbance of storage or utilization of vitamins. He feels that the last word has not been said in regard to nicotinic acid, and many would disagree with his point of view that pellagra is no longer a major health problem in the South. There is some tendency to generalize on scanty evidence which detracts from the value of the book. Some space is given over to discussing the attitude of the rest of the country to the diseases of the South and how they have been enormously emphasized to the detriment of that section.

The book is especially recommended to nutritionists

and clinicians interested in the deficiency diseases because of the excellence of the presentation of the clinical picture of pellagra and the photographs of the lesions. However, the reader must use discrimination in his acceptance of the personal opinions advanced by the author since they are at variance with the present generally accepted views.

W. H. SEBRELL

QUOTATIONS

REPORT OF THE PRESIDENT OF HARVARD UNIVERSITY

A SPECIFIC and challenging program for the adaptation of colleges to training for war needs and a vital discussion of the moral problem now facing men of student age are contained in the annual report of President Conant to the Board of Overseers—a report necessarily devoted largely to war-time problems.

Mr. Conant offers a practical outline for enlarged service on the part of American universities in war-time, and states that the question of whether a student should or should not volunteer is a personal decision in which the duty of the college is to give a maximum of information and a minimum of advice. Each individual must decide for himself, "for he will have to live with himself and face the consequences of the decision for the remainder of his days."

A PROGRAM FOR WARTIME

The requirements of the nation now take precedence over all other considerations, the president declares, and the immediate future of our universities depends upon the settlement of the relation of the university's educational work to the mobilization of young men for the fighting forces. For the satisfactory solution of this problem Mr. Conant proposes a threefold plan:

(1) An authoritative and comprehensive survey of the country's needs for trained men and women, including a survey of the present supply of skilled man power in non-defense industries.

(2) Additional thought to the possibility of more extended use of the colleges and universities for the training of officers.

(3) Consideration by the government of a modified system for selecting candidates for commissioned rank —a system which might include selection of potential officers after graduation from high school and a government-financed education combining both military training and college work.

A SURVEY OF MAN POWER

During the past year, Mr. Conant recalls, American colleges and universities have been helping to build up a reservoir of trained talent in different areas. Local draft boards have deferred the induction of advanced students of special subjects, but no quantitative estimate of supply and demand has been made. He declares:

Now that there is just one object before the country, namely, the winning of the war as speedily as possible, such a quantitative appraisal not only becomes feasible from a practical point of view but vitally important. Unfortunately it is not possible to appraise the needs for university graduates in the post-war period. One can estimate the country's requirements for the prosecution of a war in terms of men as well as material. It would be possible, for example, to state how many air pilots or physicists will be needed. But no one can say how many architects or economists will be required in an America returned to peace. Without in any way minimizing the importance of informed leadership in the post-war world or the difficulties of winning the peace, we must recognize that a speedy victory is the prerequisite to any post-war world worth organizing. It is for war, therefore, and not for peace that we must now lay our immediate educational plans.

OFFICER TRAINING

Concerning the more extended use of the colleges for officer training, Mr. Conant cites the past value of the Army and Navy R.O.T.C. and the present service which these organizations are doing. One unfortunate aspect of the situation, he says, is the "unequal distribution of opportunities for officer training among the various colleges." If there is sufficient need under the expanded program of the armed forces, an increase in the size of the units might be desirable. At present, he says, there are at Harvard many more potential officers among the students than can be cared for by the R.O.T.C.

The president notes that two objections have been made to more extensive officer training in the colleges. The first is the fear of educators that it would result in dilution and militarization of the curriculum and conversely (on the part of military men), that officer training could be done better in independent camps devoted entirely to military subjects. The second objection—that the expansion of the R.O.T.C. would result in recruiting officers from one economic level—is more serious, the president maintains. Despite state- and city-supported institutions and the scholarship plans of the privately endowed colleges, most American college communities are recruited principally from the more prosperous third of the nation. Yet, he argues, even under Selective Service, will the corps of officers be built from one economic group tending to place college men in the vast majority?

If the country, then, really wishes to develop all

ities for recruiting its officers for the Army on a demo-tic basis, should it not direct its attention to the possi-ity of a new policy based on the selection of promising ys at the time of graduation from high school? . . . e potential officers should be selected on their qualifica-ns for leadership and irrespective of the financial status their parents. They could be inducted into some form military organization as privates, and be sent at gov-ment expense to our colleges to be trained as officers R.O.T.C. units. A general program in the first year of lege would serve as the basis of a further selection; an ensified program in the following years of college could be as short or as long as the Army might decide. eferably, these men should not be under complete mili-y supervision during their collegiate work, but rather a special furlough arranged with sufficient pay to cover ir expenses.

Almost all the youth of the country attend high ool, but under normal circumstances less than one ten goes to college, Mr. Conant says. From the nt of view of democratic society and the future the Army and Navy, this selective system of pick-officers "would seem to justify the expenditure of ds required." For a long war it would guarantee pply of the best officer material in each age group h some background of education beyond the secon-y school level, and without regard to the accidents parental fortune. The president adds:

This last result would not constitute the least of the its of such a plan. For if under the terrific pressure major military effort, we can preserve and extend the erican tradition of equal opportunity—opportunity for —we shall have taken a long stride toward demon-ting that we can fight this war without sacrifice of e ideals for which the issue has been joined.

The Undergraduate's Problem

Reviewing the plans for a general speed-up of the versity curriculum on a twelve-month basis (*Bulle-* January 10), President Conant summarizes the tions between the average college undergraduate the armed forces in war time. The university accelerated its program to enable men in college nish their academic work before joining the armed es and at the same time has not relaxed the funda-tal requirements for a degree.

With the lower limit of call under Selective Service t twenty years of age, it is important, Mr. Conant hasizes, that a way be open for younger men to certain branches of the Army of their own free He cites Secretary Stimson's statement that under twenty are needed because the combat ser-"must contain individuals possessing keenness, siasm, daring, vigor and endurance." Says Mr. nt:

this, as in preceding wars, it seems that able-bodied young men as yet untrained as specialists must largely determine their own futures. The decision is a difficult and trying one for a young man to make. But each individual must make it for himself, for he will have to live with himself and face the consequences of the decision for the remainder of his days. The question of whether or not he can be of greater service by volunteering for active duty or by taking another path can only be settled by each person for himself—settled on the basis of the best evidence he can command and in the light of his own convictions.

Selective Service is, in general, a rational and fair way of building an army. We must recognize, however, that it has certain limitations and that these limitations place a heavy burden on our younger college students. . . . The duty of the college to all its students, as I see it, is to give them the maximum of information and the minimum of advice. Certainly no one would wish to lower the morale of a nation embarked on a critical struggle by dampening the fighting spirit of those who are eager to join the colors. The national government may at some later time prohibit students with certain talents from enlisting. In the meantime college faculties and administrative officers can hardly undertake to shoulder the responsibility of directing the future of those who wish to join the fighting forces.

Faculty and Defense

Evidence of the "spirit that prevails" can be found in the unanimous vote of the faculty to place themselves at the disposal of the university for a twelve-month year without additional compensation, President Conant continues.

Already many men of the faculty have been engaged for a year and a half in an "ever-increasing load of defense work." These activities have included those professors who have devoted a portion of their time to government work in Washington or are on leave of absence for this purpose; staff members on leave of absence with the armed forces; research workers under government contract; and those taking part in educational programs connected with the defense effort.

In his article in the last *Bulletin* (January 10, 1942) Dean George H. Chase, '96, mentioned the serious loss of faculty personnel which the university is facing and cited figures showing how many Harvard teachers are giving full- or part-time to the cause of victory. Since last week these figures have been revised enough to be certain that more than 100 members of the faculty have now been granted leaves of absence for defense work (74 received leave in September, 1940, and 63 in September, 1941, although some of these leaves overlap). At least 142 members of the faculty are known to be engaged in part-time war work, and Mr. Chase declared that 286 are now engaged in defense work of some sort in addition to their teaching loads. This number is swelling daily. The *Bulletin* hopes to

print more definite information on the subject in the near future, when the university will have more complete records.

The whole story can obviously not be told because so much of the work is of a secret character. But, as Mr. Conant says in his annual report, "if the whole story could be told, it would demonstrate a record of national service among members of the university staff which would be a deep source of pride to all Harvard men." He writes:

> The first asset of a modern university is neither its invested capital nor its plant. The first asset is the faculty. In all our attempts to conserve dollars during the war emergency, therefore, we must be certain that we do not impair the quality of our staff. . . .
>
> During the war years and particularly when hostilities cease, we must bend every effort to strengthen each of our dozen faculties by the addition of the ablest teachers and the most distinguished scholars available. If we succeed in this endeavor we shall insure a brilliant future for this university, whatever fluctuations in our financial fortunes may occur. If we fail, it will be of little moment to the nation whether the figure representing Harvard's dollar assets has moved up or down.—*Harvard Alumni Bulletin.*

SPECIAL ARTICLES

A FACTOR IN DOMESTIC RABBIT PAPILLOMA TISSUE HYDROLYZING THE PAPILLOMA VIRUS PROTEIN[1]

THE virus of infectious papillomatosis[2] is seldom demonstrable[3] in domestic rabbit growths. On the other hand, growths occurring under natural conditions in cottontail rabbits usually yield highly infectious extracts.[2] Further, the virus can be obtained as a homogeneous protein from growths in cottontail rabbits but not from growths in domestic rabbits.[4] The chief reason for suspecting virus in most domestic rabbit warts is the presence of a specific antigen which immunizes[5] other rabbits against infection with the virus. Even in this respect, there is evidence that virus as such is not present in suspensions of the growths, for the antigen is retained by Berkefeld filters, through which the virus readily passes, and is sedimented in ultracentrifugal fields which do not affect the virus. An explanation for the absence of virus and an insight into the probable nature of the antigen of domestic rabbit warts is suggested in the results of the experiments described here.

There is evidence that the papilloma virus is a macromolecular nucleoprotein.[6,7,8] The protein, introduced into susceptible hosts, gains entrance into epidermal cells and there progressively increases in quantity in cottontail and, presumably, also in domestic rabbits. It is conceivable that in these cells there exist not only factors which participate in the synthesis of the virus protein but others which may degrade it. In domestic rabbits the activity of the degrading factors may keep pace with that of factors influencing synthesis. The present work demonstrates a factor, presumably an enzyme, in domestic rabbit wart tissue which hydrolyzes the papilloma virus protein.

TABLE 1

THE EFFECT OF DOMESTIC RABBIT PAPILLOMA TISSUE ON THE PAPILLOMA VIRUS PROTEIN AS MEASURED BY FORMOL TITRATION. THE AMINO NITROGEN WAS DETERMINED BY THE VAN SLYKE METHOD ON THE TRICHLORACETIC ACID FILTRATE

	Time (hours)	cc 0.01 N NaOH: Papilloma tissue + virus protein	Papilloma tissue	Virus protein
	0	2.0	2.0	0.43
	3.3	2.4	1.8	0.43
	21.5	3.6	2.4	0.43
	30.5	4.5	3.2	0.78
Total virus protein N	0	0.3 mg		0.3
Amino N found (Van Slyke)	30.5	0.16 mg*		0
Amino N equivalent (from formol titration)		0.13 mg		
Percentage of total N as Amino N (Van Slyke)		53		0

* In excess of the amount present in the filtrate of papilloma tissue alone.

Table 1 shows a typical experiment with papilloma tissue from the domestic rabbit. The rabbit was inoculated broadcast with the virus protein in scarified areas on the abdomen and sides. The resulting confluent growths were sliced off when 1–2 mm high, washed free of blood in 0.9 per cent. sodium chloride solution, and ground with sand in 0.05 M phosphate buffer pH 6.5. The tissue suspension was decanted, diluted and 1.0 cc was added to each of 2 tubes. To one tube 1.0 cc of solution containing 2.0 mg of virus protein was added and to the second 1.0 cc of water. In a third tube 1.0 cc of buffer was added to 1.0 cc of

1 This work was aided by the Dorothy Beard Research Fund and by a grant from Lederle Laboratories, Inc., Pearl River, N. Y.

2 R. E. Shope, *Jour. Exp. Med.*, 58: 607, 1933.

3 R. E. Shope, *Proc. Soc. Exp. Biol. and Med.*, 32: 830, 1935.

4 J. W. Beard, W. R. Bryan and R. W. G. Wyckoff, *Jour. Infect. Dis.*, 65: 43, 1939.

5 R. E. Shope, *Jour. Exp. Med.*, 65: 219, 1937.

6 D. G. Sharp, A. R. Taylor, D. Beard and J. W. Beard, *Jour. Biol. Chem.*, 142: 193, 1942.

7 H. Neurath, G. R. Cooper, D. G. Sharp, A. R. Taylor, D. Beard and J. W. Beard, *Jour. Biol. Chem*, 140: 293, 1941.

8 A. R. Taylor, D. Beard, D. G. Sharp and J. W. Beard, *Jour. Infect. Dis.* Submitted for publication.

virus protein solution. 0.2 cc of 0.1 M NaCN and 0.1 cc of toluene were added to all tubes which were then incubated at 37° C. Immediately and at intervals samples were withdrawn for formol titration. At the end of the experiment an equal volume of 20 per cent. trichloracetic acid was added to the remaining solutions, and the amino nitrogen was determined on the filtrates by the Van Slyke method.

Table 1 shows that the papilloma tissue itself undergoes autolysis, but in the presence of the virus protein more carboxyl groups are liberated. Since the virus alone remains stable, this increase in carboxyl groups may be attributed to the hydrolysis of the virus by the papilloma tissue. The results of the amino nitrogen determination on the trichloracetic acid filtrate confirm this; 53 per cent. of the total virus protein nitrogen was liberated as free amino groups. Under exactly similar conditions the virus was not hydrolyzed by papilloma tissue from cottontail rabbits, although the tissue alone showed some autolysis. The virus was also not hydrolyzed when it was incubated with normal domestic rabbit epidermal cells[9] treated in the same way.

It appears that the papilloma virus protein is hydrolyzed by some factor, presumably an enzyme, in domestic rabbit papilloma tissue which was absent in the cottontail rabbit wart tissue thus far studied. In the experiment shown in Table 1 the weight of papilloma tissue was not more than 0.2 gm, and the quantity of virus changed was 1.05 mg. Other experiments gave similar results, and the rate of hydrolysis was not increased by doubling the virus protein concentration. Crystalline horse serum albumen and the macromolecular component of normal chick embryo[10] were not hydrolyzed by the domestic rabbit papilloma tissue. The indication is that the catalyst is specific for the virus protein or similar compounds.

The results demonstrate a mechanism by which the papilloma virus may be degraded as fast as it is formed in domestic rabbit papilloma tissue. It is possible, though no evidence of it was seen here, that such a mechanism may operate in lesser and varying degree also in cottontail rabbits to account for variations in the virus content, especially in experimentally induced growths.[4] The findings are not incompatible with the antigenicity of domestic rabbit wart material, for the antigen could well be a non-infectious, insoluble and possibly partially denatured degradation product of the virus, somewhat analogous to the degraded virus antigen of equine encephalomyelitis vaccines.[11] The possibility exists that a similar mechanism accounts for the absence of virus from the carcinoma based on the papilloma of domestic rabbits,[12] as well as that which derives from papillomas of cottontail rabbits.[13] The cells of the latter may acquire virus-degrading factors or enzymes in the carcinomatous change. It is an obvious possibility that such factors may prevent the recovery of a causative agent from neoplastic growths other than those associated with the papilloma virus.

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THE RESPIRATION OF ELODEA

MEASUREMENTS of respiration on higher aquatic plants are seldom performed. The present investigation, originally to determine the relation of cation intake to gaseous metabolism, provided a better insight into the metabolic implications of a hydrophytic existence. Slight modifications of the Fenn-Ledebur[1] microrespirometer allowed simultaneous measurement of carbon dioxide production and oxygen consumption of excised leaves of *Elodea canadensis* Michx. with facility. A barium hydroxide solution was used to absorb the carbon dioxide, and its conductance was measured at intervals by the use of the Kohlrausch bridge method. Experiments averaged three hours in length and were performed in the dark.

Respiratory quotients were very high (average 8.4), suggesting the possible occurrence of anaerobiosis, possibly in connection with or in addition to the utilization of chemically bound oxygen. Presence of previously stored substrates rich in chemically bound oxygen would decrease the amount of free oxygen necessary for complete combustion, would lower the apparent oxygen consumption, and thus cause the R.Q. to rise. Substances like oxalates and citrates would serve well as such substrates; in fact, calcium oxalate has been identified in cell vacuoles of elodea leaves.[2] Migration of oxalic, citric or other acids to

[9] For this, layers of cells were thinly shaved from the ears and abdominal skin. The results are of dubious significance for the amount of cells thus obtainable is minute.

[10] A. R. Taylor, D. G. Sharp, D. Beard and J. W. Beard, SCIENCE, 94: 613, 1941.

[11] D. G. Sharp, A. R. Taylor, H. Finkelstein, D. Beard and J. W. Beard, *Proc. Soc. Exp. Biol. and Med.*, 43: 650, 1940.

[12] P. Rous and J. W. Beard, *Jour. Exp. Med.*, 62: 523, 1935.

[13] J. G. Kidd and P. Rous, *Jour. Exp. Med.*, 71: 469, 1940.

[1] Wallace O. Fenn, *Am. Jour. Physiol.*, 84: 110, 1928. J. Frhr. v. Ledebur, *Mikrochemie*, Pregl-Festschrift (Sonderband), 253, 1929.

[2] Daniel Mazia and Jean M. Clark, *Biol. Bull.*, 71: 306, 1936.

the surface of the tissue would liberate carbon dioxide from the carbonate-incrusted leaves, also apparently increasing the R.Q. According to Gregory and Sen,[3] the rate of liberation of carbon dioxide may indicate the rate at which the protein cycle, involving deamination and protein synthesis, is taking place.

Chemical storage of oxygen is obviously of advantage to the plant, since it is not only subjected to widely varying degrees of oxygen tension in its aquatic environment, but photosynthetic activity in the winter months is apt to be curtailed. In this connection it was interesting to note the change in gaseous metabolism as the rainy season (1940–41) drew to a close. From January to mid-March the oxygen consumption rose about threefold, the carbon dioxide production neither rising nor falling conspicuously. This change was presumably conditioned by an increase in illumination, causing an increase in photosynthetic activity, in turn causing storage and subsequent breakdown of carbohydrates, and in this manner involving a shift to aerobic oxidation. It is conceivable that the oxygen consumption may also have been affected by the cessation of dilution of the pond water by rain and commencement of concentration of ions by evaporation loss. Further pursuit of these questions should throw more light on the physiology and ecology of such forms.

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ON THE SIZE AND SHAPE OF THE TOBACCO MOSAIC VIRUS PROTEIN PARTICLE

THE proposition that the tobacco mosaic virus protein is molecularly dispersed in aqueous solution has been staunchly defended by Stanley and his coworkers. In response to a paper by Bawden and Pirie,[1] who originally demonstrated that this virus protein has a marked tendency to aggregate, Loring, Lauffer and Stanley[2] announced that the virus protein "has a molecular weight of at least 46 million, a length of at least 430 millimicrons, and an effective diameter of about 12 millimicrons," and that aggregation, if any does occur in the virus protein solutions, is of little significance. Essentially this same point of view has been maintained consistently by Stanley and his coworkers, although in more recent papers, in particular those relating to the research with the electron microscope,[3,4] they speak of a "marked tendency of the particles to aggregate." These workers have avoided consideration of the various anomalies shown by solutions of this virus protein and they consider the size and shape of the protein particles arrived at from ultracentrifuge and viscosity studies as valid and accurate. The electron microscope photographs are cited as substantiating evidence, and the conclusion is reached from a consideration of these photographs that the length of the protein molecule is 280 millimicrons. This conclusion is reached notwithstanding the fact that there are many particles shown in the electron microscope photographs that are considerably shorter than 280 millimicrons.

One might be expected to suppose that all molecules of a given species would be of the same size. In the case of a protein preparation having a heterogeneous size distribution one would suspect either that the preparation is impure or that association or aggregation has occurred, in which case the size of the various particles would be simple multiples of some basic unit. Fortunately in the case of the electron microscope photographs of this virus protein, the sizes of the various particles may be measured, albeit the accuracy is not of a high order. It is impossible, for example, to be sure that all the particles are lying flat, and measurements made from a half-tone reproduction are not particularly satisfactory. Although the errors in the estimations of the lengths of the virus protein particles from these and similar photographs are large, a length distribution curve for 159 particles occurring in the photographs published by Stanley and Anderson[3] and Anderson and Stanley[4] is presented in Fig. 1.

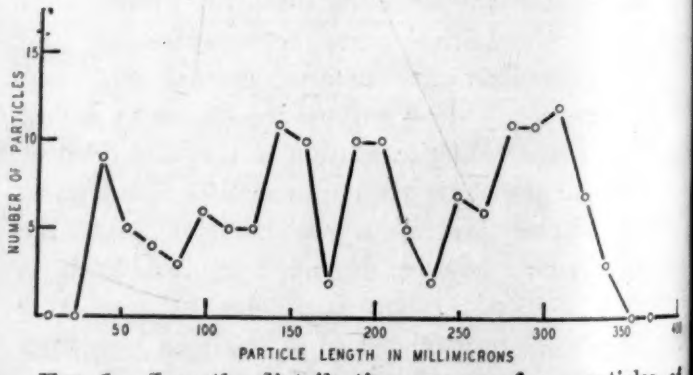

FIG. 1. Length distribution curve for particles of tobacco mosaic virus protein. Data taken from electron microscope photographs.

The class length along the abscissa is 15 millimicrons. Note that a bunching occurs at lengths in the regions of 300, 190, 150, 100 and 37 millimicrons. These lengths are essentially in the ratio of 8:5:4:3:1.

The implications of the orderliness indicated above are obvious.

An added item of interest is the observation by Melcher, Schramm, Trurnit and Friedrich-Freksa[5] that the electron microscope photographs of their

[3] F. G. Gregory and P. K. Sen, *Ann. Bot.*, n.s. 1: 521, 1937.
[1] *Proc. Roy. Soc.*, B 123: 274, 1937.
[2] *Nature*, 142: 841, 1938.
[3] *Jour. Biol. Chem.*, 139: 325, 1941.
[4] *Jour. Biol. Chem.*, 139: 339, 1941.
[5] *Biol. Zentr.*, 60: 524, 1940.

preparations showed particles whose lengths were predominantly in the neighborhood of 140 and 190 millimicrons. In keeping with their decision that the length of the virus protein molecule is 280 millimicrons, Stanley and Anderson[3] concluded that Melcher and coworkers must have been dealing with some different strains of the virus. These same particle lengths occur in the electron microscope photographs published by Stanley and Anderson[3] and by Anderson and Stanley.[4]

A further consideration of equal interest is that the size of the suggested basic unit from which the other particles seem to be built is in good agreement with the "diameter" of some 38 millimicrons arrived at by Thornberry[6] from ultrafiltration experiments. One might wonder just what the electron microscope photographs of these ultrafiltrates would show.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

CHROMATOGRAPHIC SEPARATION OF MIXTURES OF AMINO ACIDS

THE recent report by Tiselius[1] of the adsorption analysis of certain mixtures of amino acids by a modification of the Tswett chromatographic method has led us to publish at this time results of our own work.

We have been able to separate mixtures of *l*-tyrosine and *dl*-leucine, and of *dl*-phenylalanine and *dl*-leucine, in a quantitative, or nearly quantitative manner. Other separations, such as that of *l*-tyrosine from *dl*-phenylalanine or of glycine from *dl*-alanine, have been obtained but are not yet quantitative. A representative experiment is given below. We hope shortly to publish our findings in full.

Materials. A variety of *adsorbents* have been investigated. The experiment described below employed a commercial carbon, Darco G–60.[2] *l*-Tyrosine, partially racemized, analyzed 7.69 and 7.75 per cent. nitrogen and gave no nitroprusside test for cystine. *dl*-Leucine analyzed 10.71 and 10.74 per cent. nitrogen.

Experiment. Two grams of Darco G–60 carbon were mixed with filter paper pulp (a convenient, non-adsorbing bulking agent) and packed in a tube 2.2 cm in diameter to give a column of adsorbent 12 cm long. To this was applied a solution containing 0.5006 g *dl*-leucine and 0.1008 g *l*-tyrosine in 100 cc of water. The column was developed with water in the usual manner and without pressure. The liquid which passed through the column was collected in fractions and analyzed for amino acid. All the leucine was obtained in the first 600 cc of liquid which passed through the column (0.5016 g in 15 fractions), and in no fraction was there any evidence of tyrosine (Folin-Marenzi test). At this point all the tyrosine remained on the column and the percolating liquid gave a negative ninhydrin test and a negative Folin-Marenzi test.

The strongly adsorbed tyrosine could be desorbed by elution with aqueous ethyl acetate: 550 cc of 5 per cent. aqueous ethyl acetate removed about 90 per cent. of the tyrosine (by colorimetric estimation, checked gravimetrically).

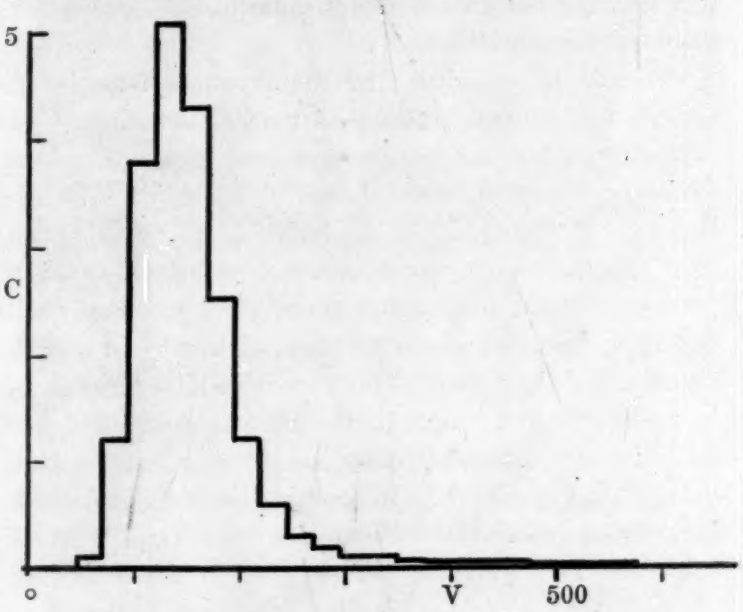

FIG. 1

"Zone" of *dl*-leucine.
V Volume of percolate, in cc.
C Concentration of fractions shown, in mg. per cc.

The concentrations of leucine in the fractions of percolate are plotted (Fig. 1) against the volume of percolate to show how the "zone" passed completely from the column. This method of plotting is useful in dealing with the separation of colorless materials.[3]

This problem is being developed further in this laboratory.

At this time we would like to express our thanks to Dr. Hubert B. Vickery and Dr. Werner Bergmann for many kindnesses, and to the International Silk Guild for funds in support of this work.

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[1] A. Tiselius, SCIENCE, 94: 145, 1941.
[2] The Darco Corporation, 60 East 42nd Street, New York, N. Y.
[6] *Phytopathology*, 25: 601, 1935.
[3] H. G. Cassidy, Dissertation, Yale University, 1939; E. Caliri, Thèse, University of Fribourg, 1939; H. G. Cassidy, *Jour. Am. Chem. Soc.*, in press.

CEREAL CELLULOSE, A ROUGHAGE MATERIAL SUITABLE FOR EXPERIMENTAL ANIMAL DIETS

MANY animal diets are deficient in material that supplies bulk or roughage and carries moisture through the intestines. It has become a rather common practice of nutritionists to add agar to basal diets for its laxative value. Because of its indigestibility and its gel-forming properties it is effective in furnishing bulk and carrying moisture. Lately, however, it has been observed that agar is not nutritionally inert, particularly in that it carries significant amounts of biotin and possibly other factors. The main supply of agar comes from Japan and hence a serious shortage is imminent. Because agar is important for bacteriological work in hospitals and food manufacture and for research it is desirable to conserve it for these most essential uses.

The use of cellulose for dietary roughage is of course well known, as it is a normal constituent of herbivorous and omnivorous animal diets. For experimental diets it must be available in a substantially pure state and in a desirable physical form. For a number of years a cereal cellulose of high purity from the nutritional standpoint has been used to supply roughage in a commercial breakfast cereal, namely, a flaked rice. This cereal cellulose has been in use for many years in the animal diets used for nutritional studies at Mellon Institute and at the University of Pittsburgh. It has also been utilized similarly in the research laboratories of several medical schools. The material, where used to the extent of about 5 per cent. in the diet, has been found very effective in preventing constipation. There has been no evidence of its furnishing any nutritional factors.

This special cellulose is derived from rice hulls by a series of chemical processes that remove practically all the non-cellulosic ingredients except a little coloring matter and less than 1 per cent. of a siliceous ash. It is in the form of a very light brown fluffy meal of a particle size that will pass a standard 40-mesh screen. The following are some of the analytical data for the product:

	Percentage
Nitrogen	0.043
Ash	0.71
Calcium	0.022
Phosphorus	nil
Iron	0.001
Aluminum	0.016
Silica	0.42

The product contains no protein or fat. It is so low in calcium and phosphorus that it is quite suitable for all ordinary studies on these elements. As the material is dried in a steel rotary dryer the small amount of iron contained may make it unsuitable for use in diets designed to study iron availability. A thiochrome test for thiamine gave a negative result. It has been used for years in basal diets for thiamine and riboflavin assays with the negative control diets showing growth responses indicating complete absence of these vitamins. The high-pressure chemical process of treatment together with the extensive washing of the material assures destruction or removal of all vitamins.

The cellulosic ingredients of the product include about 70 per cent. of alpha-cellulose with the rest made up of simpler celluloses and hydro-celluloses. The digestibility of the material for different animal species has not been determined, but it is believed it is largely indigestible, particularly in the white rat, in the diet of which it has proved an effective roughage material.

The cereal cellulose has been supplied gratis by the manufacturer to a few research laboratories that have requested it. Plans are under way, however, for one of the larger scientific supply houses to furnish it to all interested research organizations.

E. R. HARDING

MELLON INSTITUTE

BOOKS RECEIVED

CHAPPLE, ELIOT DISMORE and CARLETON STEVENS COON. *Principles of Anthropology.* Pp. xiii + 718. Holt. $3.75.

Contributions toward a Flora of Nevada. Division of Plant Exploration and Introduction, Bureau of Plant Industry, U. S. Department of Agriculture, in Collaboration with the University of Nevada. Numbers 1–21, 23–33.

DAVIES, A. C. *The Science and Practice of Welding.* Illustrated. Pp. viii + 436. Cambridge University Press. $2.25.

The Diseases of the Basal Ganglia. Research Publications, Volume XXI, Association for Research in Nervous and Mental Disease, TRACY J. PUTNAM, editor. 268 Illustrations, 15 Tables. Pp. xii + 719. Williams and Wilkins. $10.00.

HALL, NORRIS F. and OTHERS. *Acids and Bases.* Pp. vii + 103.

MÜLLER, OTTO H. *The Polarographic Method of Analysis.* Pp. vi + 114. Numbers 1 and 2 in *Contributions to Chemical Education.* Journal of Chemical Education. $1.00 each.

LEWIS, WARREN K., LOMBARD SQUIRES and GEOFFREY BROUGHTON. *Industrial Chemistry of Colloidal and Amorphous Materials.* Pp. xi + 540. Macmillan. $5.50.

NEGLEY, GLENN. *The Organization of Knowledge.* Pp. xvi + 373. Prentice-Hall. $4.00.

The Psychology of Learning. Part II—The Forty-First Yearbook of the National Society for the Study of Education, edited by NELSON B. HENRY. Pp. xiv + 502. Public School Publishing Company.

RUSSELL, GEORGE E. *Hydraulics.* Fifth Edition. Pp. viii + 468. Holt. $4.75.

SHERMAN, HENRY C. and CONSTANCE S. PEARSON. *Modern Bread from the Viewpoint of Nutrition.* Pp. vi + 118. Macmillan. $1.75.

STEWART, OMER C. *Culture Element Distributions: XVIII Ute-Southern Paiute.* Anthropological Records, Volume 6, Number 4. Four plates. Pp. 231–354. University of California Press.

NEW WILEY BOOKS

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SCIENCE NEWS

Science Service, Washington, D. C.

DISTANT GALAXIES

EXPLORING outwards in the time and space of the universe, Dr. Harlow Shapley, director of the Harvard Observatory, in the closing address of the Inter-American Astrophysical Conference in Mexico City, declared that by studying hundreds of thousands of great systems of stars, each comparable to our own Milky Way, it should be possible to work out whence our own system of stars came and where it is going.

Already Dr. Shapley has directed a census of these galaxies out to a distance of 100,000 light years (600,000,000,000,000 miles). More than 400,000 new systems have been discovered. About a thousand million million stars are involved in this gigantic study of the whole sky, now two thirds complete.

The new Schmidt-type telescope, dedicated at Tonanzintla last week, the largest of its kind reaching southern regions of the sky, is specially well suited to the study of these faint external galaxies. Three quarters of these great aggregations of stars have spiral arms which hitherto have been thought of as streams of stars thrown off from the central portion of the galaxy. Dr. Shapley told the conference that these arms actually appear to be condensations within the systems rather than ejections from the center masses.

Measuring photographic plates with electrical measuring instruments more sensitive than the human eye, the Harvard measurements reported by Dr. Shapley show that only a fifth of the light of a spiral galaxy is in its arms and most of it is in the little-noticed background of the galaxy.

Recent Harvard studies show that our own galaxy, the nearest stars of which we see in the night sky, is larger than supposed. Variable stars, used by astronomers as yardsticks, have been found as distant as 30,000 light years on the other side of the center of the galaxy.

Evidence that the Small and Large Magellanic Clouds may be physically connected was presented by Dr. Shapley. An extension or wing of the Small Magellanic Cloud was discovered and has been shown to be attached to it. This wing extends outward to the Large Cloud.

Out of such studies, Dr. Shapley predicted, will come more information on deeper problems, such as the age of the universe, and whether it is finite in size and material, or limitless in one or both of these quantities.

OTHER PAPERS READ BEFORE THE INTER-AMERICAN ASTROPHYSICAL CONFERENCE

FROM Einstein's special relativity theory, Dr. George D. Birkhoff, of Harvard, has derived the famous values for the change in the planet Mercury's perihelion and the curvature of light passing by the sun. These predictions were first made by Einstein on the basis of his general relativity, which followed his special relativity theory by some years. Their experimental confirmation enthroned relativity as a dominant law of the universe. Dr. Birkhoff announced his success to the conference. He urged consideration of Einstein's special and general theories of relativity in relation to quantum mechanics. He also recalled that in 1926 he had demonstrated that Schroedinger's quantum mechanics could be derived from general relativity, which was another bringing together of fundamental conceptions in theoretical physics.

A very short life for the universe so far—a mere two or three billion years—was suggested by new theories of evolution of the stars presented by Professor H. N. Russell, of Princeton, a leading authority on the life and death of stars. This is only about the age of the oldest rocks on the earth and it may mean that the earth is as old as the rest of the universe. Professor Russell's new theory takes into account the recent ideas that the stars are kept shining by means of the energy they obtain from transmutations of the atoms that compose them. The older ideas of thirty years ago, proposed by Professor Russell at that time, pictured the stars as undergoing a regular evolution, one sort turning into another. He now concludes that, puzzling as it may be, the white dwarf stars have not arrived at their present state through an evolutionary process but were "born" that way. The supergiants, blazing at a great rate, consume so much energy that they could not have kept up that pace during the new short lifetime of the universe. It is, therefore, suggested that these stars had an existence during which they did not shine, but were actually 170 degrees below zero Centigrade on their surfaces.

Everything on earth, even the meteoritic importations from outer space, are the same age, about two to two and a half billion years, according to Dr. Robley D. Evans of the Massachusetts Institute of Technology. This suggests that the "pebbles from heaven" as well as the earthly elements themselves were formed at the same time. Dr. Evans used a new method of determining age. He estimated ages from the relative activities of long-lived radioactive isotopes or varieties of some elements. In terrestrial samples the radioactive isotopes of uranium, potassium, carbon, oxygen and others always occur in the same proportions, suggesting that they were all formed at the same time. Measurements of meteorites show the same relative abundance of the isotopes. This checks well with earlier age determinations upon iron meteorites and earthly rocks by measuring the amounts of helium produced as by-products of radioactive disintegration.

HIGH PRESSURES

How boiling hot ice and other weird things occur at extremely high pressures was told at the Iowa State College at Ames by Dr. P. W. Bridgman, Hollis professor of mathematics and natural philosophy at Harvard University. He spoke at Iowa State College under the auspices of the Sigma Xi, national fraternity for the promotion of scientific research, and will give the Sigma Xi

lecture at a number of other colleges and universities during the next few weeks.

Dr. Bridgman also described the steps by which pressures in his laboratory have been successively raised from a previous high of 3,000 atmospheres or 45,000 pounds per square inch, the maximum employed in artillery, to the present record of 400,000 atmospheres. This is 6,000,000 pounds per square inch, the pressure that would be found under a tower of bricks nearly 1,500 miles high, or at a point in the interior of the earth over 1,000 miles below the surface.

Even at this extreme pressure, graphite refused to change to diamond, and Dr. Bridgman believes that this feat, which nature herself accomplishes so sparingly, can not be done at ordinary temperatures, no matter how high the pressure.

More than boiling hot ice was produced at a much lower pressure. At 40,000 atmospheres, ice was produced at a temperature of approximately 375 degrees Fahrenheit. This is 163 degrees above the usual boiling point of water, nearly as far above it as the boiling point is above the freezing point.

Hot ice is indeed not ordinary ice, but it differs from the latter practically only in that its volume is less; it sinks in water, and its melting point is raised with increasing pressure, contrary to the behavior of ordinary ice. This explains why it does not melt at high temperatures if the pressure is sufficiently raised. Six of these other kinds of ice emerge at different pressures. Nearly all substances behave in the same way. Eleven kinds of solid camphor, six kinds of bismuth, appear as these substances are compressed.

Physical properties change remarkably. Poor conductors of electricity become fair conductors, and good conductors become sometimes better, sometimes worse.

OLD COTTON FIELDS AND FISH PONDS

BIG crops of fish can be raised on old cotton fields in the South—fields too worked-out to produce paying land crops any longer. The system has been developed by Dr. J. S. Swingle and Dr. E. V. Smith, of the Alabama Agricultural Experiment Station at Auburn. All that is necessary is a field and a creek, so situated that a low earth dam will turn the field into a shallow pond. The water, instead of the soil, then receives a fertilizer application and is stocked with fish. Bass, catfish and bream are regarded as most promising.

High food yields at low costs have been obtained in the experiments. As much as 600 pounds of fish per acre, at production costs between three and six cents a pound, have been taken out of the ponded fields. Comparable fields used as pastures yielded only 149 pounds of beef per acre, at much higher per-pound cost.

The fertilizers used are the regular commercial kinds, applied at a rate of 100 pounds to an acre. Results were improved by adding ten pounds of nitrate to the regular fertilizer mixture. Too much fertilizer resulted in the growth and decay of such an excess of aquatic plant and animal life that the water was robbed of its oxygen and the fish smothered. Moderate fertilizer applications, therefore, are emphasized as essential to the success of the method.

Fish are not directly nourished by the fertilizer. First result is the encouragement of a good growth of microscopic water plants. These become the food of microscopic animals, and these in turn are eaten by others. The fish are next to the last and largest link in the biological chain of eat-and-be-eaten. The last and largest link of course is the field owner and his family, who get sport, increase and new variety in daily menu, and cash from the sale of surplus fish.

BACTERIOSTATIC ACTION OF SULFANILAMIDE

NEW research confirming earlier evidence that sulfanilamide attacks bacteria by literally starving the germs may provide a hopeful method of "making drugs to order" for specified germs. Until recently, pharmacologists have worked mainly on a hit-or-miss basis. Ehrlich, for example, tried 606 times before he hit on salvarsan, the specific drug for the organism of syphilis.

The new research is reported in the *Lancet* for January 10. It is described in a report by Dr. Sydney D. Rubbo and Dr. J. M. Gillespie, of the University of Melbourne, Australia. They found that a chemical called p-aminobenzoic acid is needed by a certain type of bacteria for growth. This acid is similar in its chemical structure to sulfanilamide. When the sulfanilamide is present, the bacteria are tricked into using it instead of the necessary acid. Since sulfanilamide does not promote growth, despite the similarity in chemical structure to the acid, the bacteria can not develop.

However, only one part by weight of the acid will offset the growth inhibitory qualities of 26,000 parts of the sulfanilamide. This is a possible explanation of why such large amounts of the drug are needed in treatment of bacterial infections.

Dr. D. D. Woods and Dr. P. Fildes, of England, had earlier discovered evidence that the acid was necessary for bacterial growth, and that sulfanilamide inhibited growth by interfering with the bacterial use of the acid. The present research confirms their evidence, while an editorial in the same issue of the *Lancet* comments that "one new and more rational method has been added to those already available in (drug) research."

THE LIVING CELL

A LONG-SOUGHT clue to a more complete understanding of the living cell, the basic unit of all life, has been found in experiments with the atom-smashing cyclotron at the University of California.

Dr. Alfred Marshak, research fellow in the Radiation Laboratory, has shown that in the first stage of development of the cell, which is called the resting phase, and during which time the cell is supposed to remain inactive, this tiny unit of life is constantly changing. One function of the cell is to reproduce, and it does this by progressing through a number of fairly definite stages until it finally splits into two cells. It is the simplest biological unit, consisting of a nucleus with chromosomes,

rod-like structures considered to be the carriers of genes, chemical entities which determine heredity.

According to classical biological teachings the cell in the resting phase is inactive. In the second phase of development the number of chromosomes doubles, in the third the membrane around the cell nucleus disappears, and in the final stage the cell splits in two. The new cells enter immediately into the resting stage, and according to the theory remain dormant for a while before they start the cycle over again.

Dr. Marshak bombarded cancer and plant cells with both x-rays and the neutron rays produced by the cyclotron, and made a comparison of the damage to the chromosomes of the cells in the resting phase. He found that neutrons produced relatively more damage to chromosomes in the resting phase. At certain definite periods in this phase the relative efficiency of neutrons in producing this damage is much greater than at others.

Dr. Marshak said that this clearly indicates distinct physiological states, rather than one inactive phase. He said that he has no idea of the character of these states, but that the evidence does give science a new clue to the functioning of life's simplest unit.

SIGNS OF SPRING

SIGNS of spring are beginning to appear: earliest violets and buttercups in the South, pussy-willows and alder catkins and skunk cabbages in the still-chilly North. First robins are being reported every day. But we really went "over the hump" of winter weeks ago, when average temperatures stopped getting lower and started getting higher.

A map of averages compiled by the Weather Bureau shows that this earliest preview of spring enters the United States at its southwestern corner, where the turn toward warmer averages occurs early in January. Across the South, and over a wide stretch up the Pacific Coast and eastward into the Great Plains, the warming-up begins during the middle ten days in January. Latest to feel the first warm breath of spring is the northeastern section, with the middle and upper Great Lakes region, where the welcome days do not arrive until the beginning of February.

Of most practical importance, in this study, is the later period when the vanishing number of frosty nights permits the planting of early crops, with reasonable assurance that they will not be frozen off after they come up.

"It is essential," according to the Weather Bureau report, "that spring crops be planted late enough to be reasonably safe from an untimely freeze after the plants have emerged, but where the advantage of maturity for early markets is a consideration the chance of damage should be considered on the basis of an economically sound safety margin."

The map shows, for example, that if early truck crops susceptible to freezing weather are planted early enough to be above ground on February 1 along the central and west Gulf coast, the chance, in the long run, that they will be killed by a freeze is only one year in ten.

ITEMS

A GUIDE to Public Vital Statistics has been published by the Work Projects Administration for 21 states, and the remaining state guides are scheduled for completion by April 1. They show where the birth records are listed in each county, city or town of a particular state, and the fee charged for the service. Copies of the guides containing birth certificate information published by the WPA are being distributed to State Departments of Health, Vital Statistics Bureaus, the Bureau of Census and to the libraries of the War and Navy Departments. They can be had by industries, recruiting officers, Selective Service boards and other official agencies by writing the WPA administrator of a particular State, or to the Washington Headquarters of the Historical Records Survey of the WPA.

THE intensity of the primary cosmic rays, as they come in toward the earth, varies with the number of spots on the sun, was stated by Professor James W. Broxon, of the University of Colorado, at the meeting in Detroit of the American Physical Society. The peak of the spots, however, occurs three or four days before the peak of the cosmic rays. The effect is supposed to be due to the magnetic fields of the spots. These variations in cosmic ray intensity produce at the earth's surface magnetic disturbances of a particular character that can be calculated and distinguished from magnetic disturbances due to other causes. This was pointed out by Dr. Foster Evans, also of the University of Colorado. If the incoming cosmic radiation consists of charged particles predominantly of one sign, he said, there must be compensating currents of slow-moving electrons in the vicinity of the earth. The earth's magnetic field would cause these electrons to spiral about the earth, and they in turn would produce a magnetic field opposing that of the earth. If the intensity of the incoming cosmic rays were constant, this diminution in the force on the compass needle would not be noticed. But variations of this intensity manifest themselves as magnetic disturbances. The calculated effects agreed with those observed.

PUTTING calcium carbide on pineapple plants to force them into bloom is the device used by planters of tropical Australia. The secret of the technique is the fact that calcium carbide is the parent stuff of acetylene, which evolves as a gas when the carbide is moistened. Acetylene is one of the hydrocarbon gases that has been used to stimulate plant processes, including blossoming. The Queensland planters, however, have found it unnecessary to go to the somewhat expensive bother of gas-treating their pineapples. They merely drop bits of calcium carbide into the heart of the leaf cluster when the plant is in bud, and the first rain, or even heavy dew, causes the evolution of the acetylene. Care has to be exercised in the treatment, because too much carbide burns the plants, too little produces no results. But experience indicates the right amount, and brings about an increase in the pineapple crop.